Figure 5–861 shows the estimated release from IDF-West to groundwater of the radiological risk drivers and Figure 5–862, the chemical hazard drivers. In addition to the waste form inventory, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. Most of the IDF-West vadose zone technetium-99 (97 percent), iodine-129 (97 percent), chromium (99 percent), nitrate (greater than 99 percent), and fluoride (greater than 99 percent) are released to groundwater during the period of analysis.

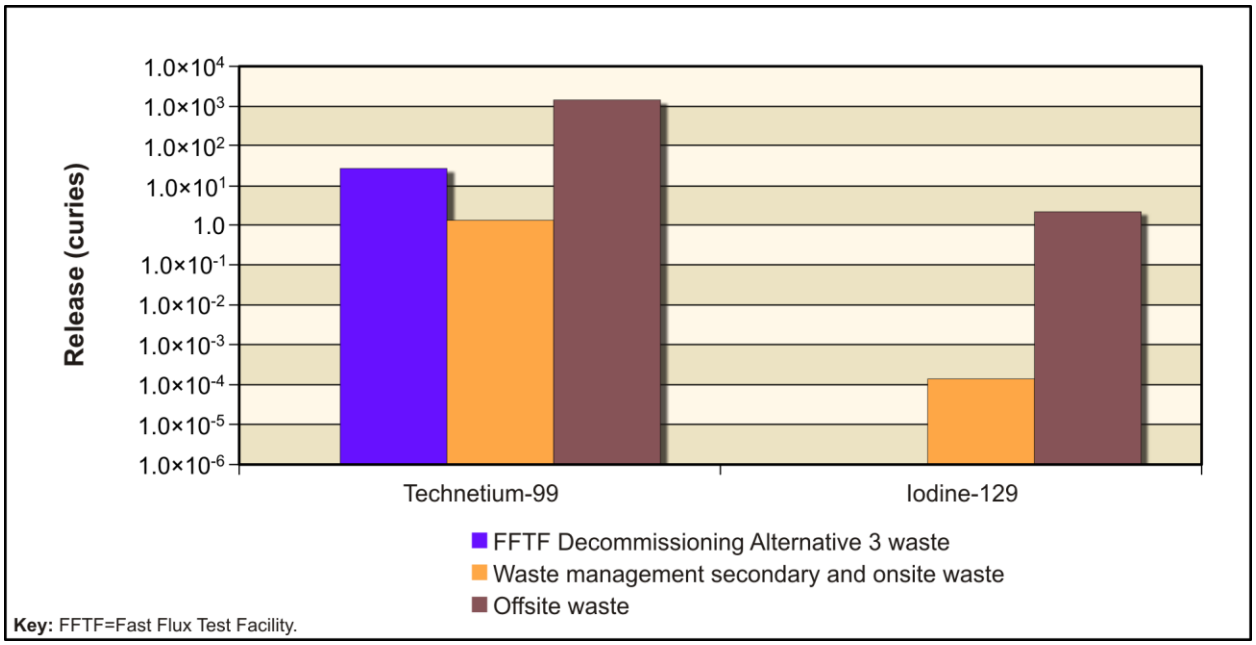


Figure 5–861. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Groundwater

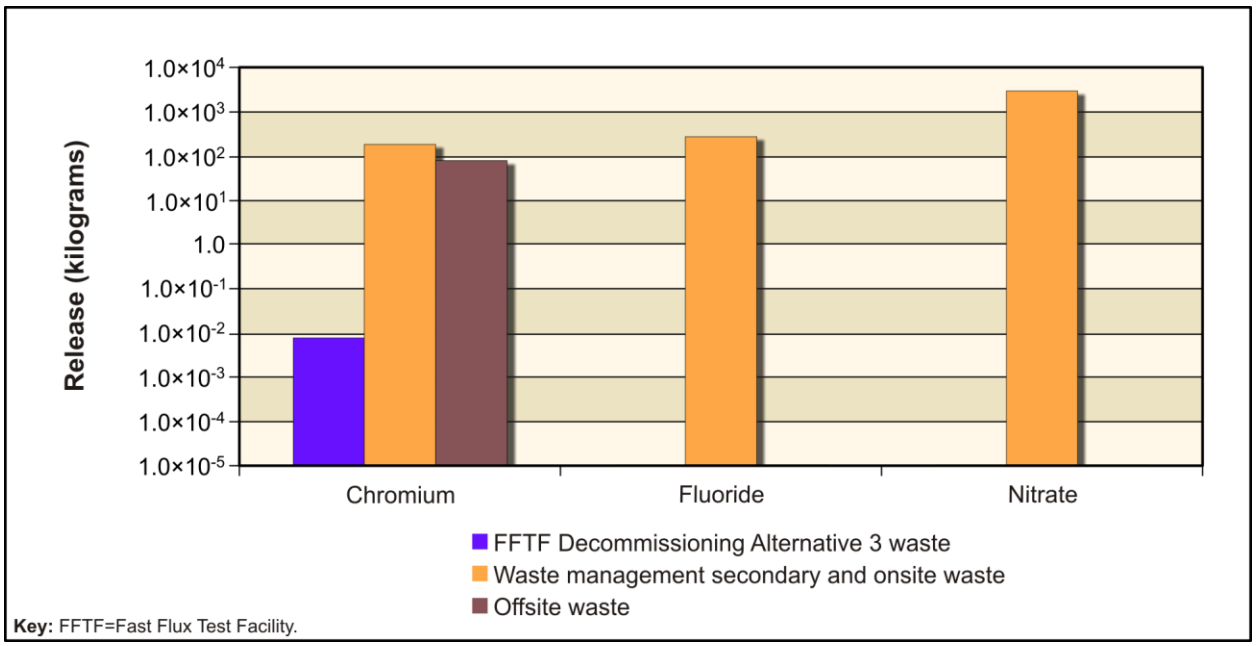


Figure 5–862. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chemical Releases from 200-West Area Integrated Disposal Facility to Groundwater

Figure 5–863 shows the estimated release from IDF-West to the Columbia River of the radiological risk drivers and Figure 5–864, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Nearly all (greater than 99 percent) of the IDF-West groundwater technetium-99, iodine-129, chromium, nitrate, and fluoride are released to the Columbia River during the period of analysis.

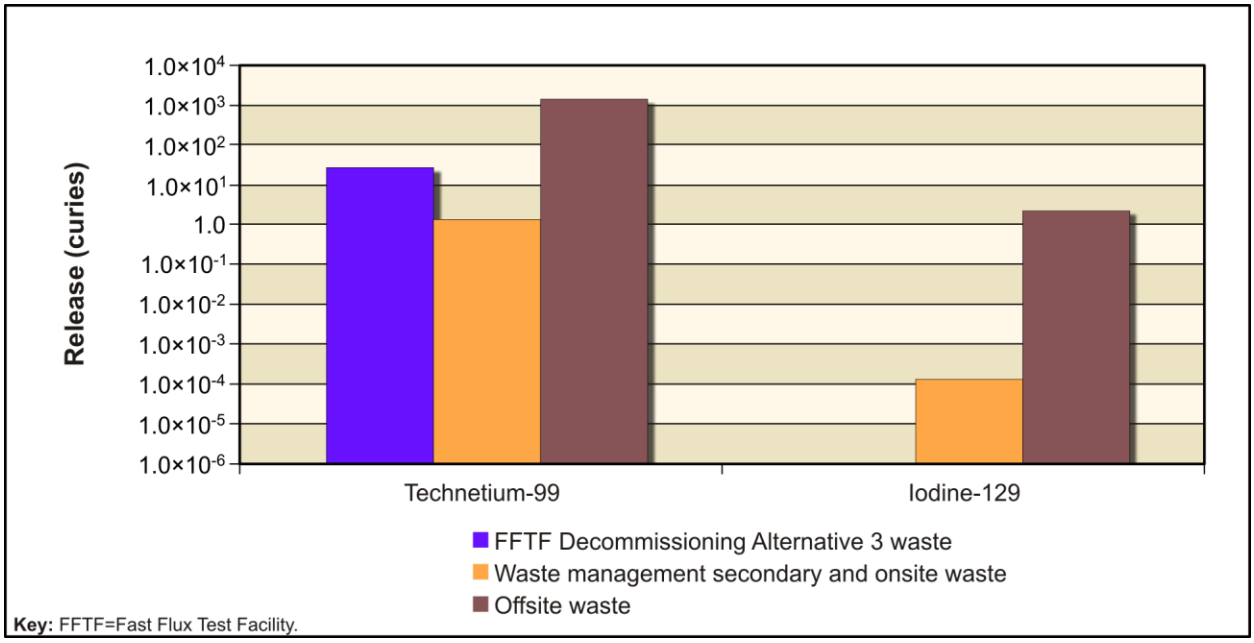


Figure 5–863. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Columbia River

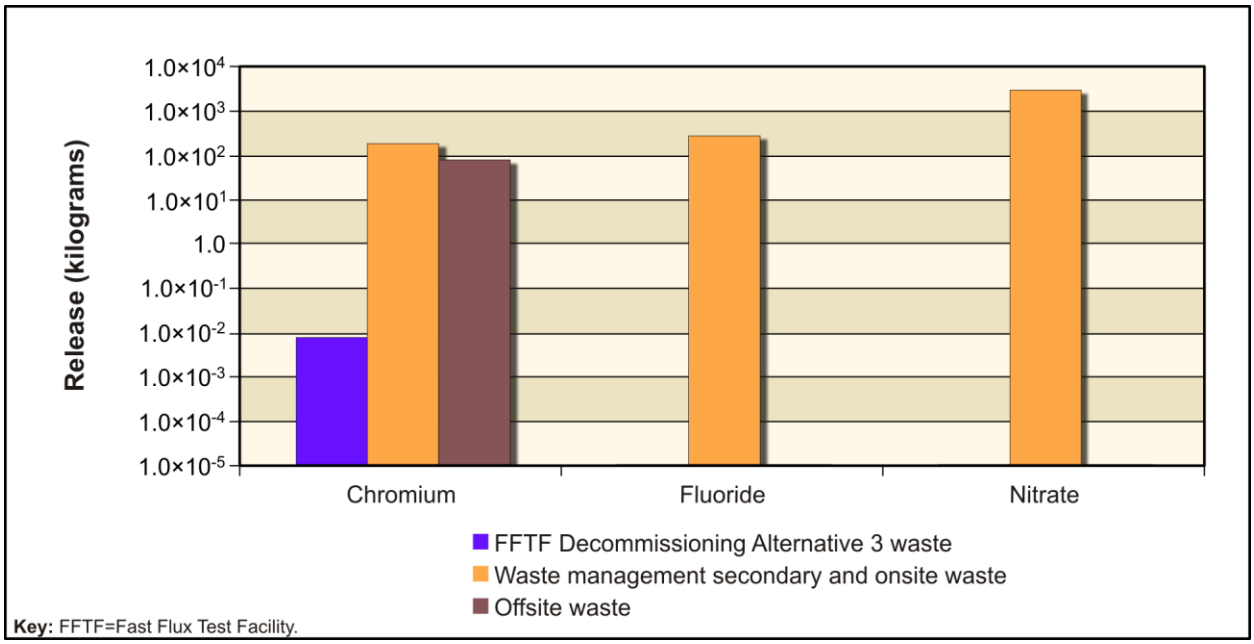


Figure 5–864. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chemical Releases from 200-West Area Integrated Disposal Facility to Columbia River

Overall, most (97 percent) of the IDF-West vadose zone technetium-99, iodine-129, chromium, nitrate, and fluoride reach the Columbia River during the period of analysis.

River Protection Project Disposal Facility

Figure 5–865 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–866, the chemical hazard drivers. Release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). Radionuclide releases from the RPPDF to the vadose zone comprise technetium-99 (largest source) and iodine-129 (smallest source). Chemical hazard releases from the RPPDF comprise nitrate (largest source) and chromium (smallest source). Fluoride is not released from the RPPDF.

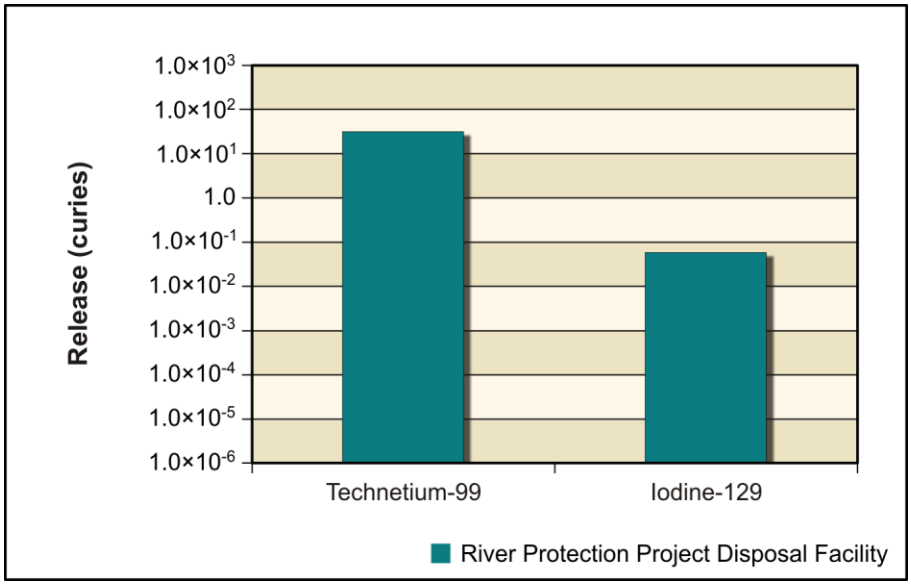


Figure 5–865. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

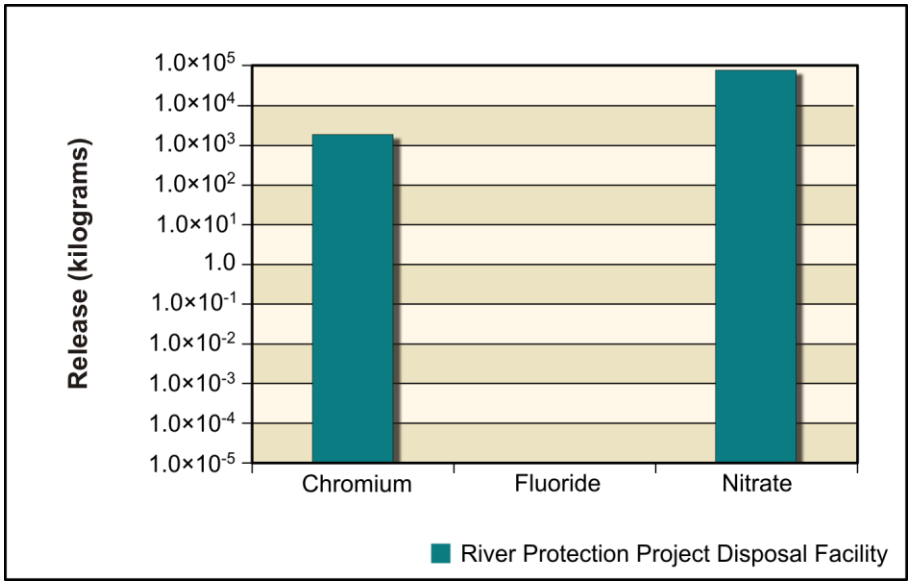


Figure 5–866. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–867 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–868, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. Essentially all (99 percent) of the RPPDF vadose zone technetium-99, iodine-129, chromium, and nitrate are released to groundwater.

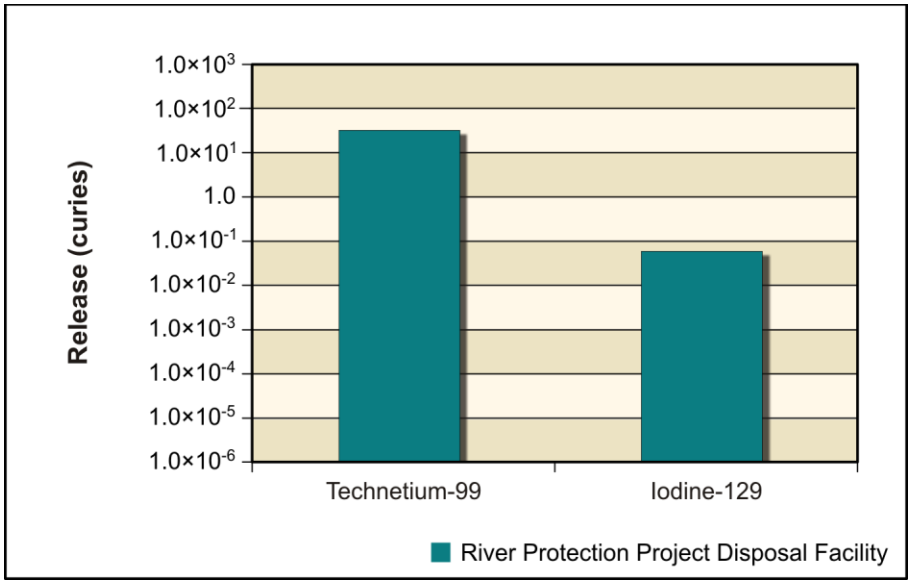


Figure 5–867. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

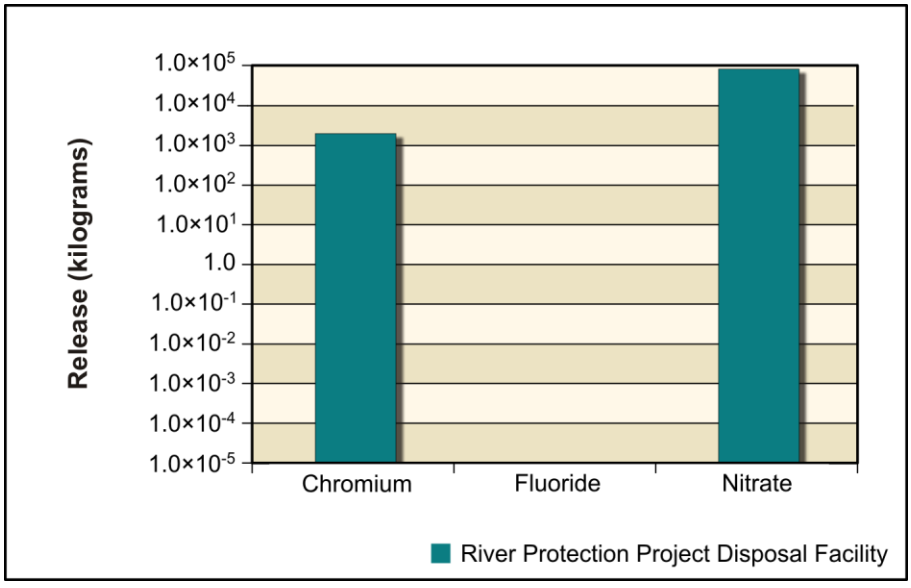


Figure 5–868. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–869 shows the estimated release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–870, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Most (99 percent) of the groundwater technetium-99, iodine-129, chromium, and nitrate are released to the Columbia River.

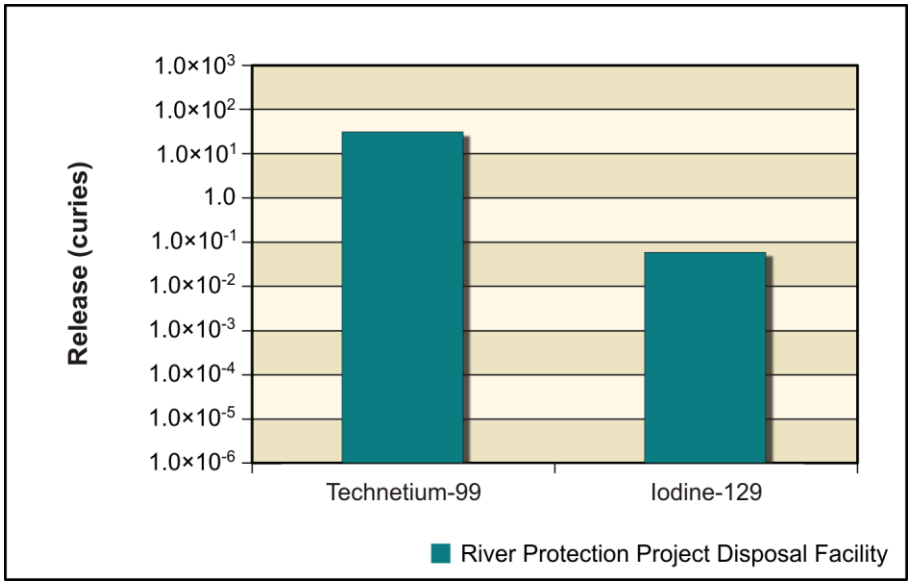


Figure 5–869. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

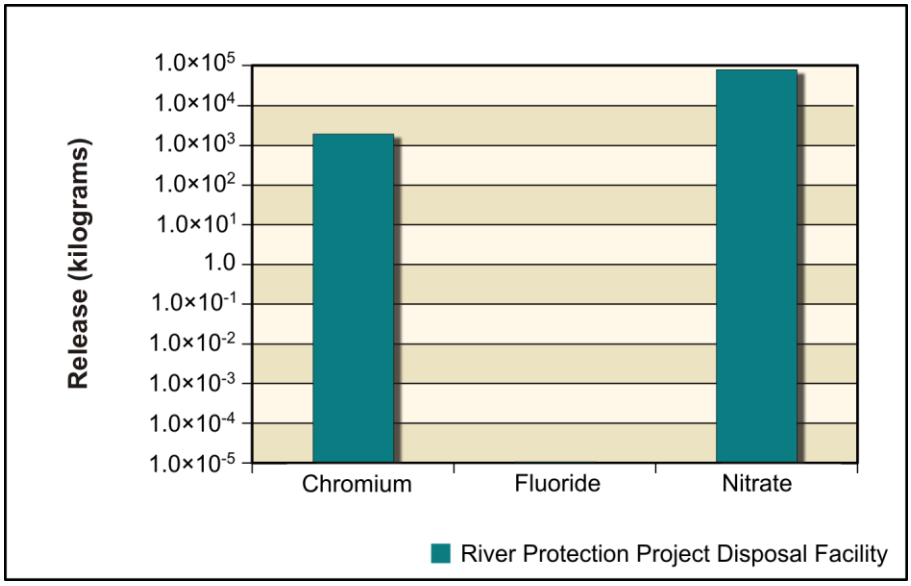


Figure 5–870. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chemical Releases from River Protection Project Disposal Facility to Columbia River

Overall, most (95–96 percent) of the RPPDF vadose zone technetium-99, iodine-129, chromium, and nitrate reach the Columbia River during the period of analysis.

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the analysis of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, impacts in terms of groundwater concentration versus time at the Core Zone Boundary and the Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. The benchmark concentration of each radionuclide and chemical is also shown. Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations. Table 5–110 shows the maximum concentrations in groundwater. Maximum concentrations of technetium-99 and iodine-129 exceed their respective benchmarks only at the IDF-East barrier, IDF-West barrier, Core Zone Boundary, and Columbia River nearshore. The only other exceedance of a benchmark concentration occurs for chromium at the IDF-East barrier in CY 9008.

Table 5–110. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Maximum COPC Concentrations in the Peak Year at IDF-East, IDF-West, and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	IDF-West	RPPDF	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	**3,840**	**13,200**	107	**1,370**	**1,670**	900
	(10,921)	(3818)	(3785)	(3859)	(3920)	
Iodine-129	0.7	**20.6**	0.2	**2.1**	**2.4**	1
	(10,997)	(3794)	(3824)	(3937)	(3872)	
Chemical (micrograms per liter)						
Acetonitrile	11	0	0	3	3	100
	(8959)	(1940)	(1940)	(8894)	(9121)	
Chromium	**175**	1	7	52	40	100
	(9008)	(3813)	(3666)	(8873)	(8827)	
Fluoride	0	1	0	0	0	4,000
	(1940)	(4014)	(3983)	(3937)	(4307)	
Nitrate	27,200	7	286	8,960	6,820	45,000
	(8700)	(3927)	(3728)	(8189)	(9059)	

Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Figures 5–871 through 5–874 show concentration versus time for technetium-99, iodine-129, chromium, and nitrate, respectively. The releases of technetium-99 from IDF-East, IDF-West, and the RPPDF result in concentrations at the IDF-West barrier, Core Zone Boundary, and the Columbia River nearshore that exceed the technetium-99 benchmark concentration over part of the period of analysis (see Figure 5–871). There is a relatively narrow technetium-99 increase after the post-disposal period, when the IDF-West barrier concentration exceeds the benchmark concentration by one order of magnitude for about 1,500 years. The peak, in about CY 3800, is less than one order of magnitude greater than the benchmark concentration at the Core Zone Boundary and Columbia River nearshore. The technetium-99 concentration at the IDF-West barrier then drops below the benchmark concentration by about one to two orders of magnitude. Technetium-99 concentrations at the Core Zone Boundary and Columbia River nearshore remain at about the benchmark level for the duration of the simulation. Technetium-99 concentrations at the IDF-East barrier begin to increase steadily beginning in about CY 4500 and exceed the benchmark concentration from approximately CY 7000 until CY 11,940.

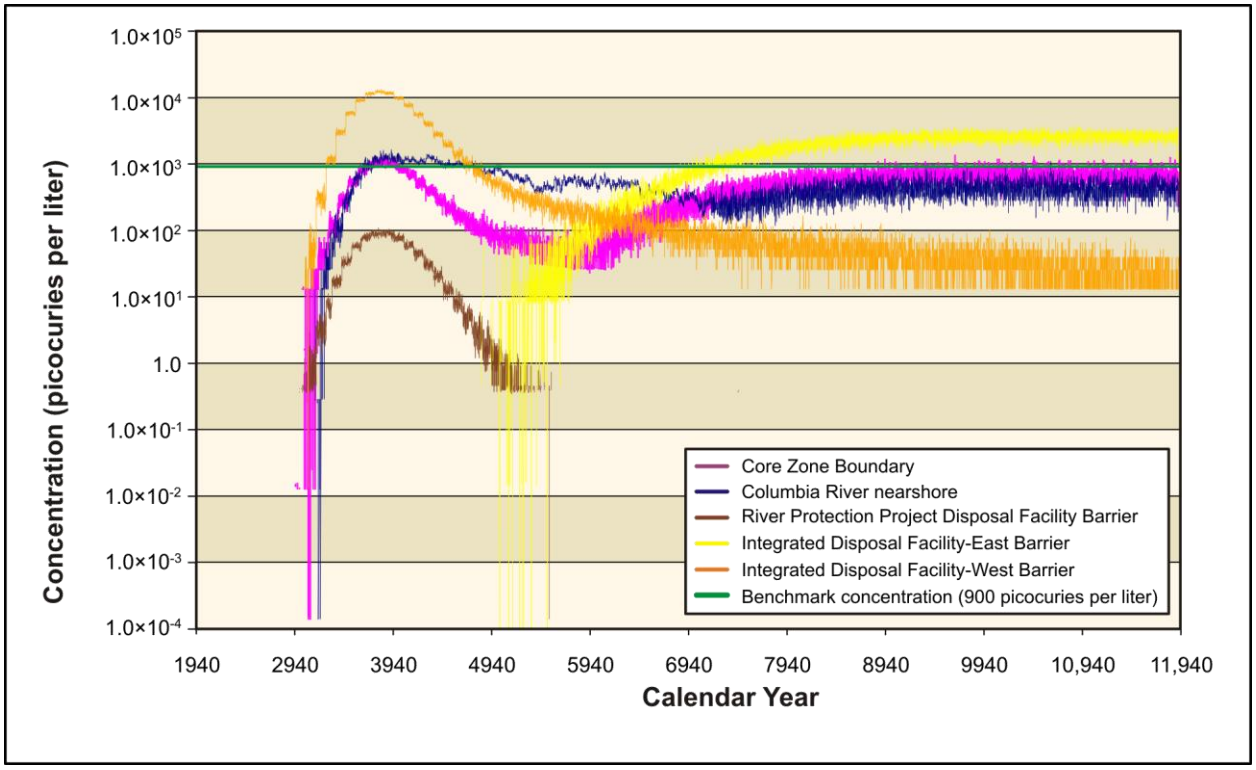


Figure 5–871. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Technetium-99 Concentration Versus Time

The iodine-129 concentration versus time (see Figure 5–872) shows a similar response at the Core Zone Boundary and the Columbia River nearshore. The iodine-129 peak in CY 3800 at the IDF-West barrier is one to two orders of magnitude above the benchmark and less than an order of magnitude above the benchmark at the Core Zone Boundary and Columbia River nearshore. The iodine-129 then decreases to an order of magnitude below the benchmark concentration level and remains steady at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore through the remainder of the period of analysis (CY 11,940). The later rise in iodine-129 concentrations at the IDF-East barrier never exceeds the benchmark concentration.

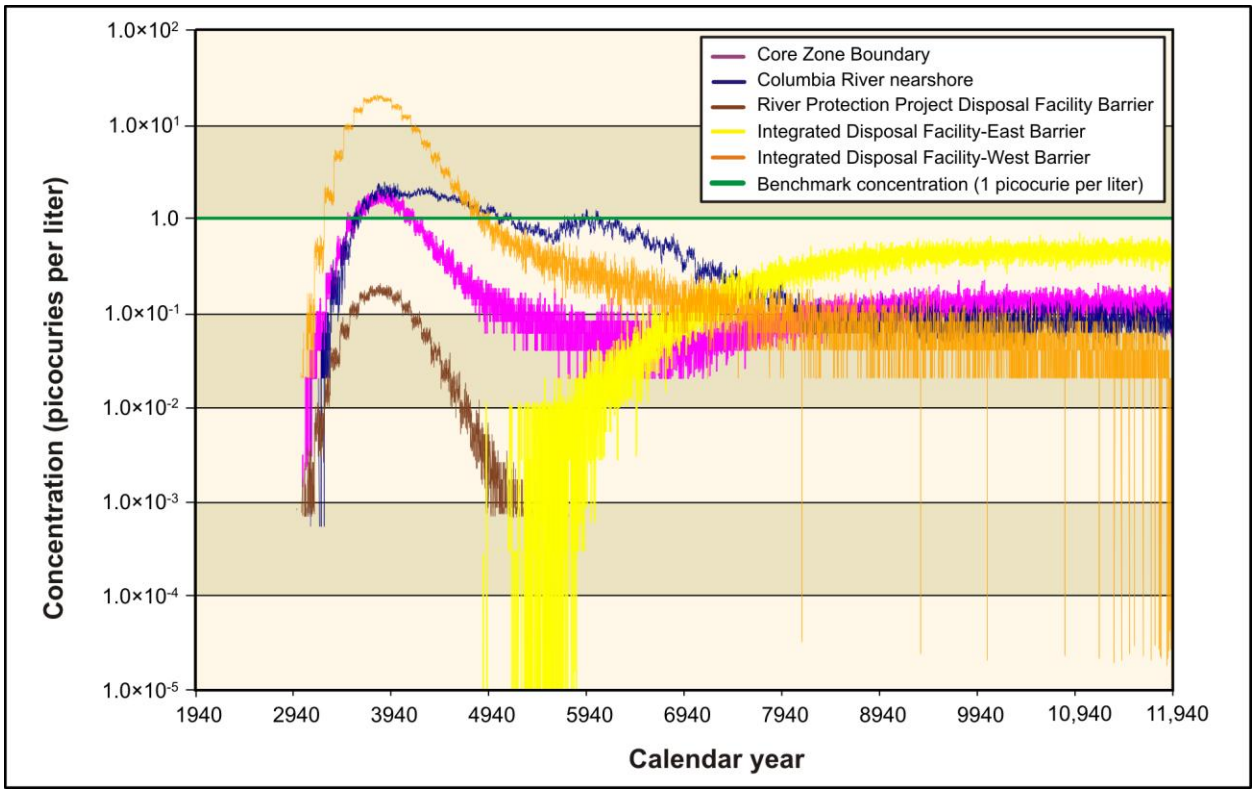


Figure 5–872. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Iodine-129 Concentration Versus Time

Figures 5–873 and 5–874 also show an initial increase in the IDF-West barrier, RPPDF barrier, and Core Zone Boundary chromium and nitrate, followed by a second, broader increase period related to the IDF-East releases that peaks at about the two-thirds point of the analysis period. The chromium concentrations exceed the benchmark concentration only at the IDF-East barrier from about CY 8000 to CY 10,000, but then decline; by CY 11,940, concentrations are about one order of magnitude below the benchmark concentration. The nitrate concentration remains less than one order of magnitude below the benchmark concentration throughout the period of analysis at the IDF-East barrier, IDF-West barrier, RPPDF barrier, Core Zone Boundary, and Columbia River nearshore.

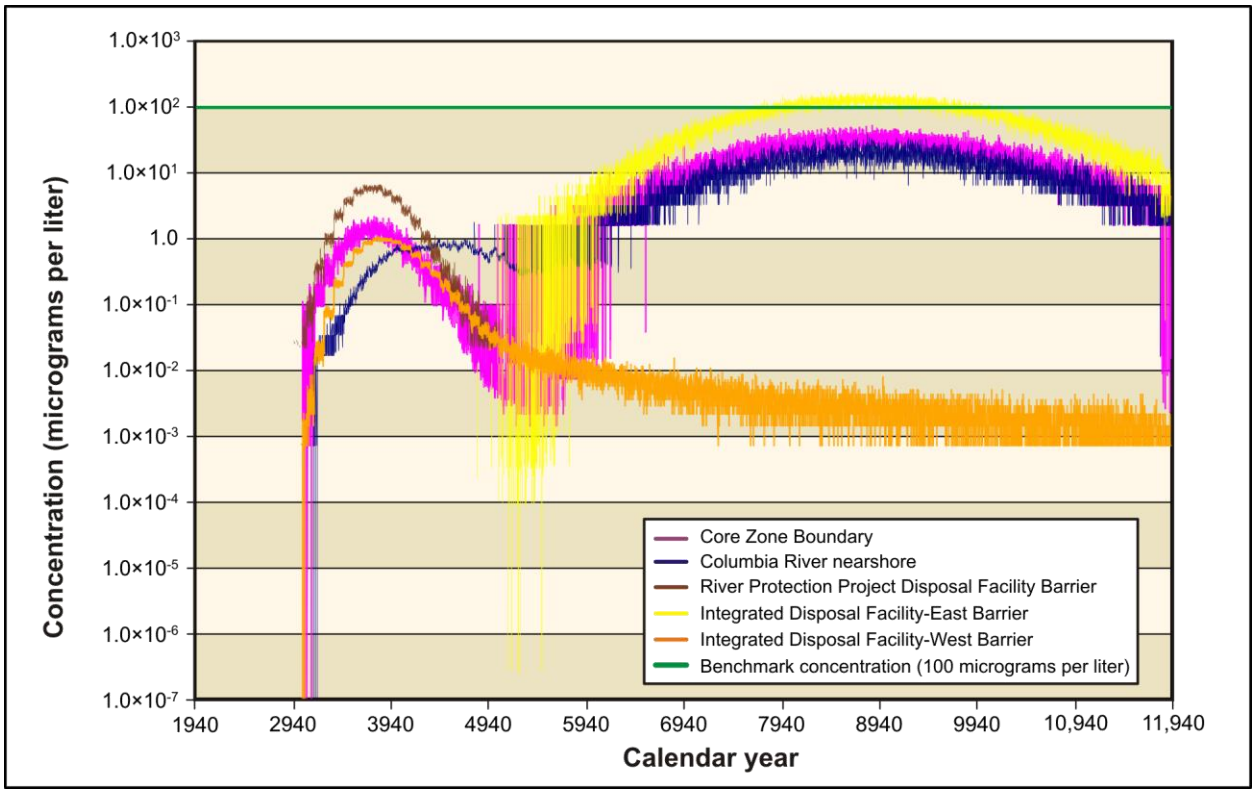


Figure 5–873. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Chromium Concentration Versus Time

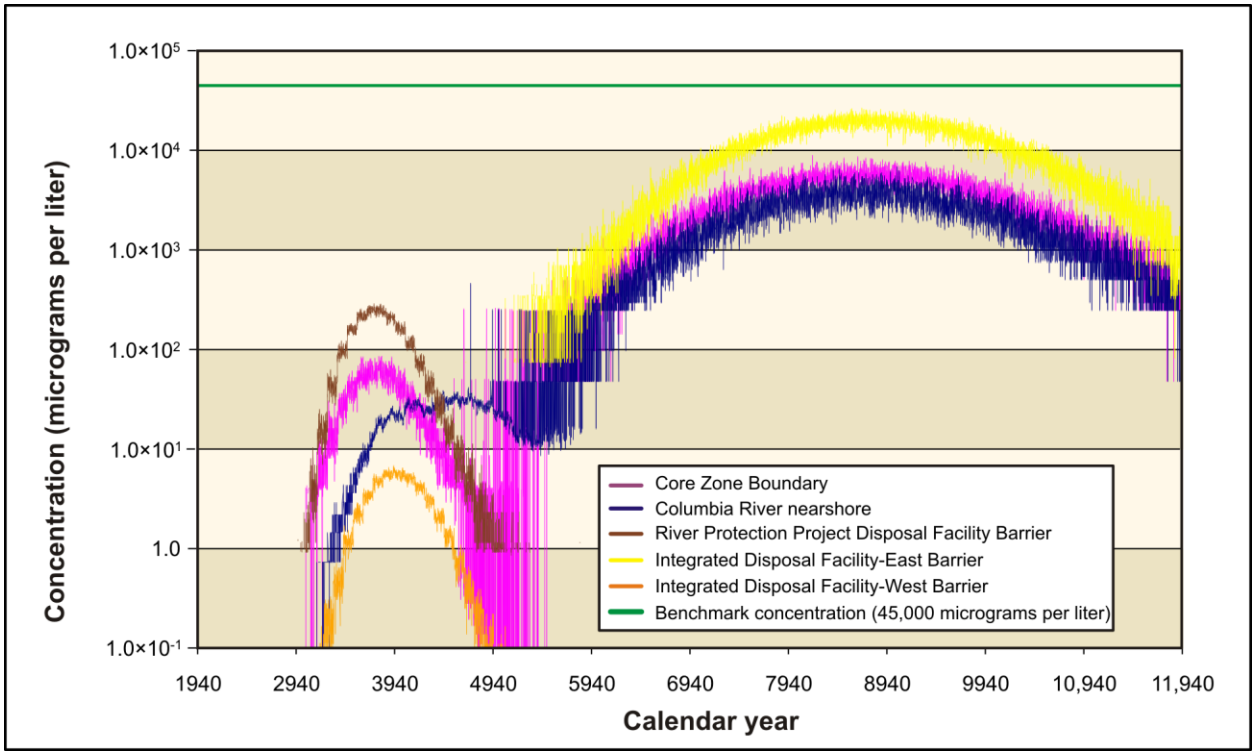


Figure 5–874. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Nitrate Concentration Versus Time

Figure 5–875 shows concentration versus time for total uranium. Because total uranium moves slowly through the vadose zone, releases from IDF-East, IDF-West, and the RPPDF result in groundwater concentrations at the Core Zone Boundary and the Columbia River nearshore that are always significantly lower than the benchmark concentrations. Toward the latter half of the period of analysis, total uranium (see Figure 5–875) concentrations at the RPPDF barrier, Core Zone Boundary, and Columbia River nearshore increase. The total uranium concentrations are less than six orders of magnitude below the benchmark concentration by the end of the period of analysis (CY 11,940).

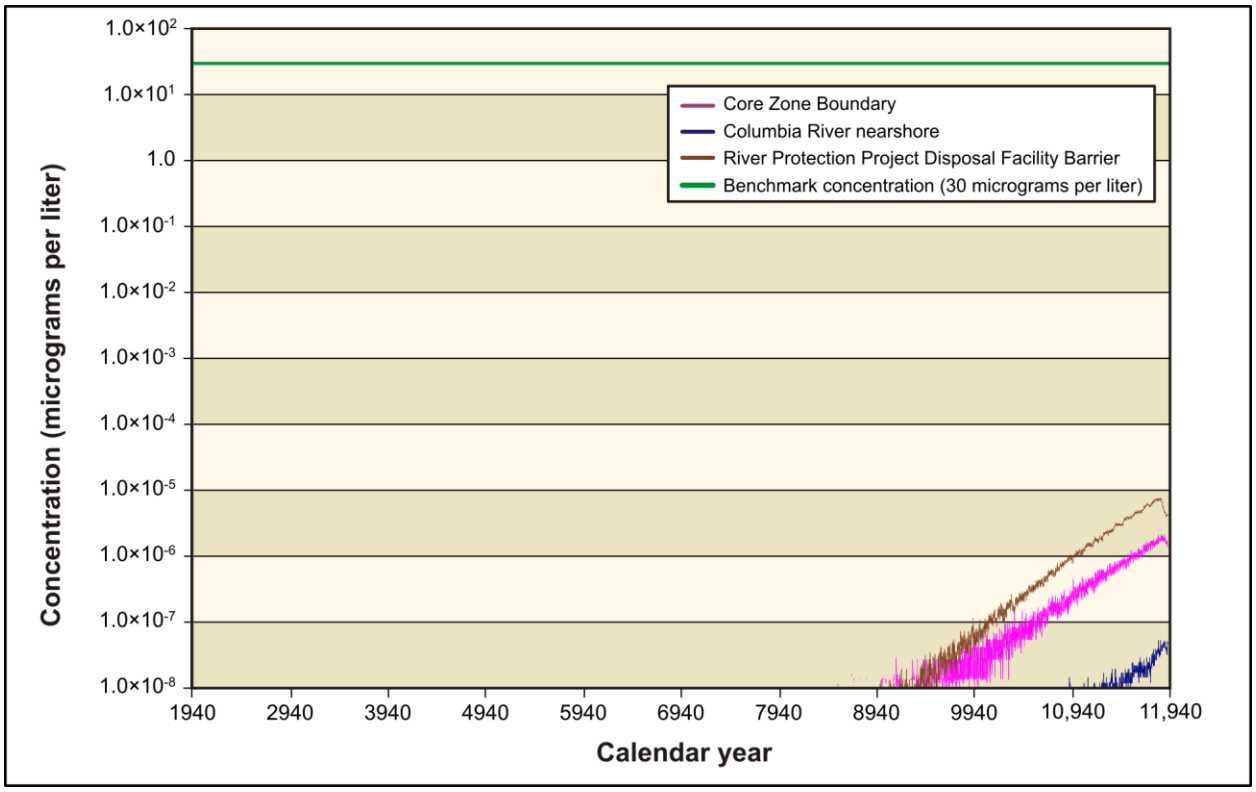


Figure 5–875. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Total Uranium Concentration Versus Time

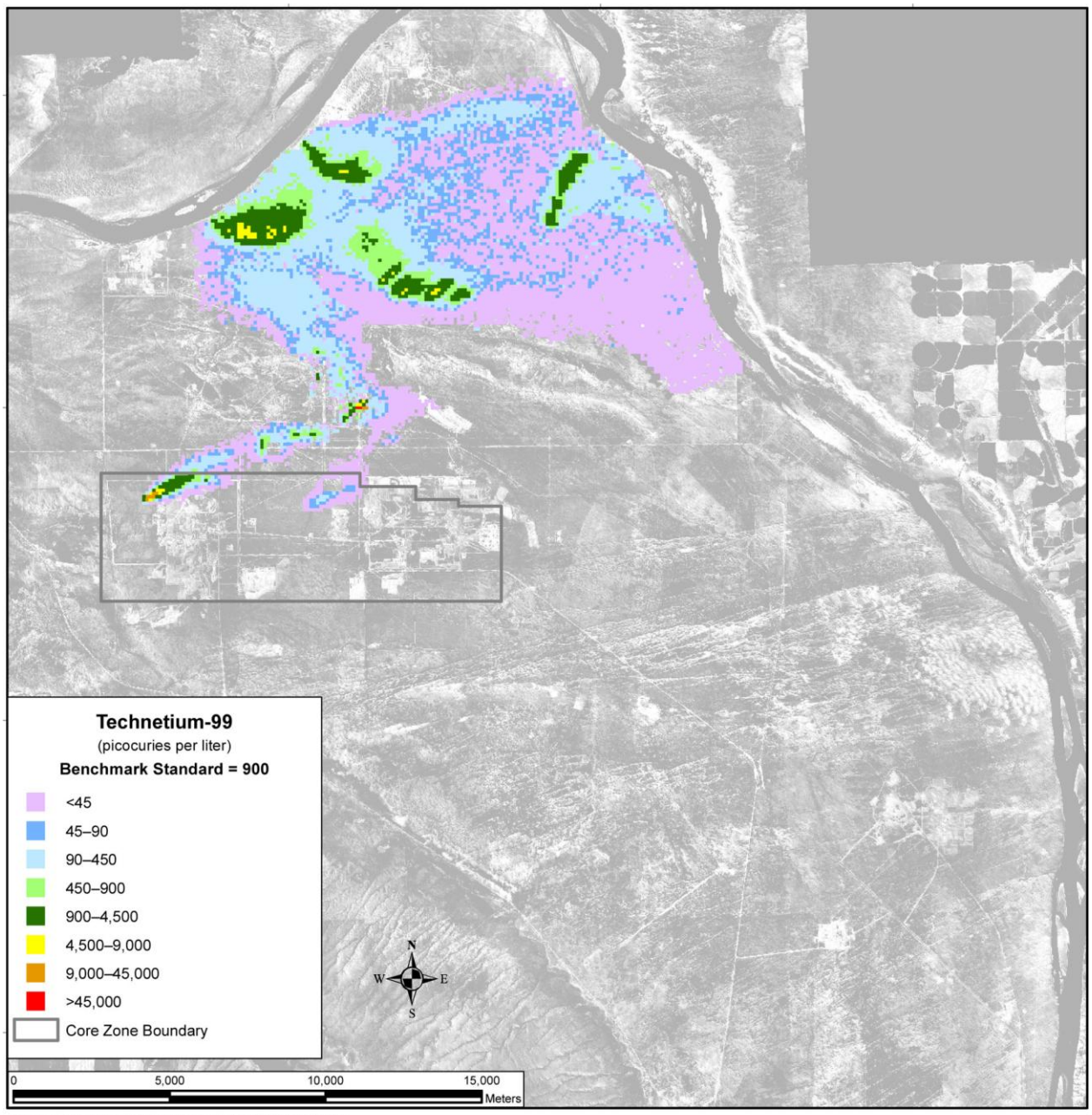
ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated by the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations.

Figures 5–876 through 5–887 show concentration distributions in CYs 3890, 7140, and 11,885 for technetium-99, iodine-129, nitrate, and chromium. Figure 5–888 shows the concentration distribution for total uranium in CY 11,885. These data show the groundwater releases from the RPPDF and IDF-West that extend north from within the Core Zone to the Columbia River. These concentration distributions show that the releases of technetium-99, iodine-129, nitrate, and chromium occur significantly earlier at the RPPDF and IDF-West than the same releases at IDF-East. The RPPDF and IDF-West releases remain

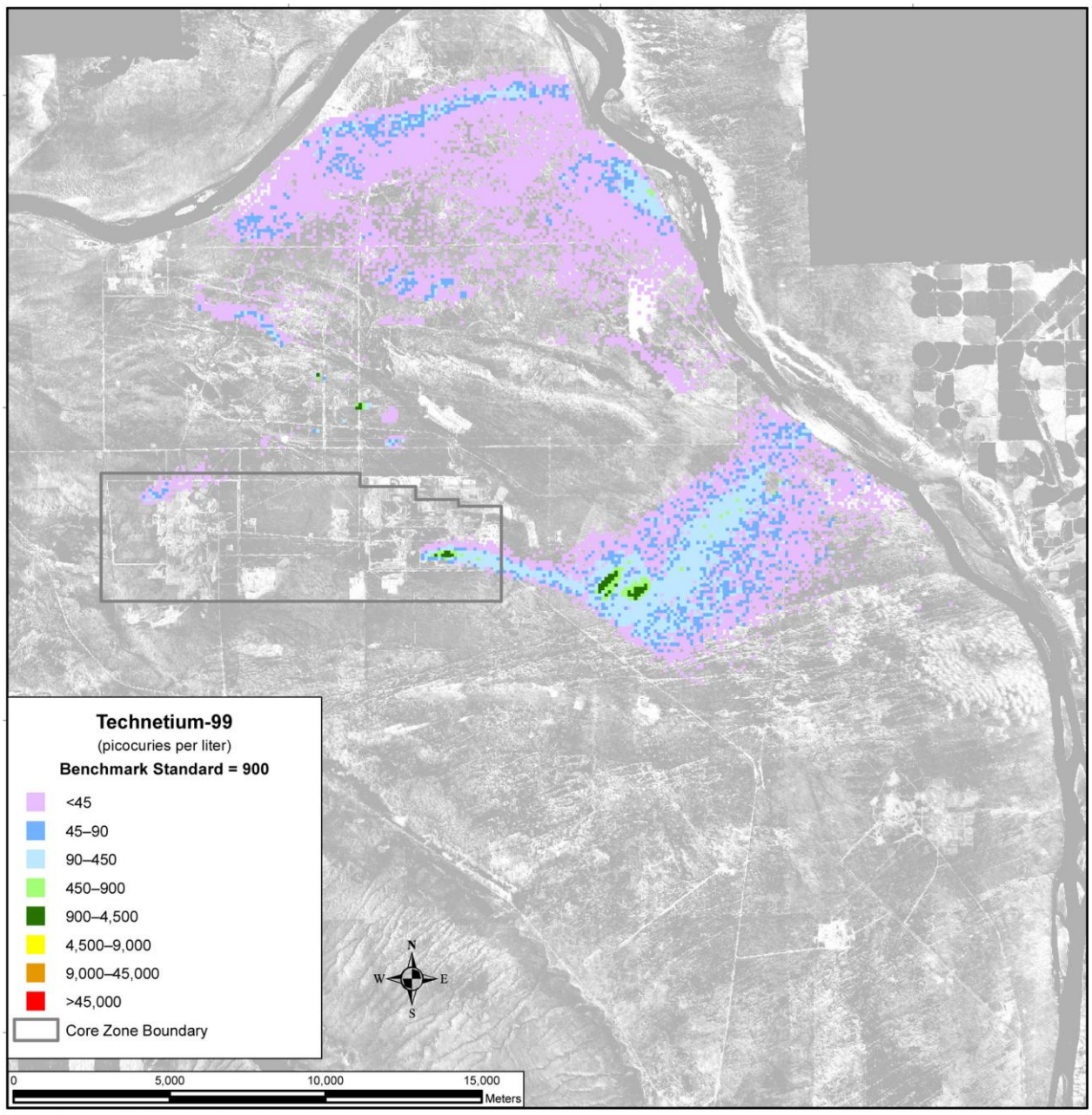
in a fairly narrow channel (Gable Gap) until about halfway to the Columbia River nearshore. The releases then spread out over the northern tip area of Hanford. The IDF-East releases remain in a relatively narrow channel until they reach about the one-quarter distance point to the Columbia River, where the releases spread out and continue to the Columbia River nearshore.

Figure 5–876 shows the technetium-99 release from IDF-West and the RPPDF in CY 3890. This spatial distribution shows that the technetium-99 exceeds the benchmark concentration within the Core Zone (due to the IDF-West release) and in several areas close to the Columbia River nearshore. There are several small areas with very high concentrations of technetium-99 (several orders of magnitude larger than the benchmark concentration) at the IDF-West barrier. Figure 5–877 shows that the technetium-99 release from IDF-West and the RPPDF has dissipated by CY 7140 and only exists in areas close to the Columbia River nearshore at concentrations at least one order of magnitude lower than the benchmark concentration. This figure also shows a technetium-99 release distribution from IDF-East. This shows significant areas where the technetium-99 approaches or exceeds the benchmark concentration. Figure 5–878 shows the continued dissipation of the IDF-West and RPPDF groundwater technetium-99 in CY 11,885. In contrast, in CY 11,885, the IDF-East technetium-99 distribution has continued to spread toward the Columbia River. In CY 11,885, significant areas exist where the technetium-99 concentrations from the IDF-East release still exceed the benchmark concentration; levels are at least one order of magnitude larger than the benchmark concentration in parts of these areas.



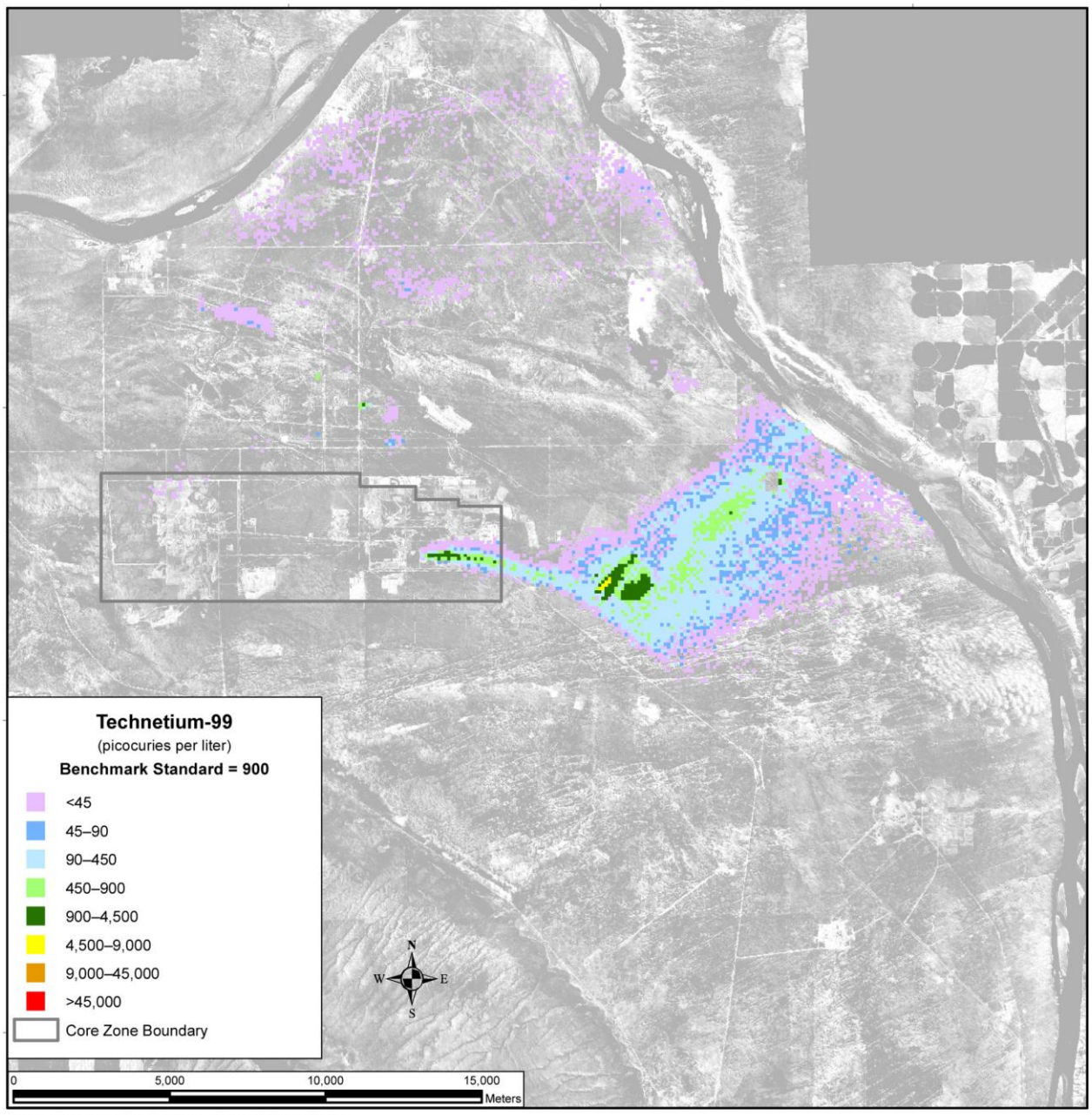
Note: To convert meters to feet, multiply by 3.281.

Figure 5–876. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

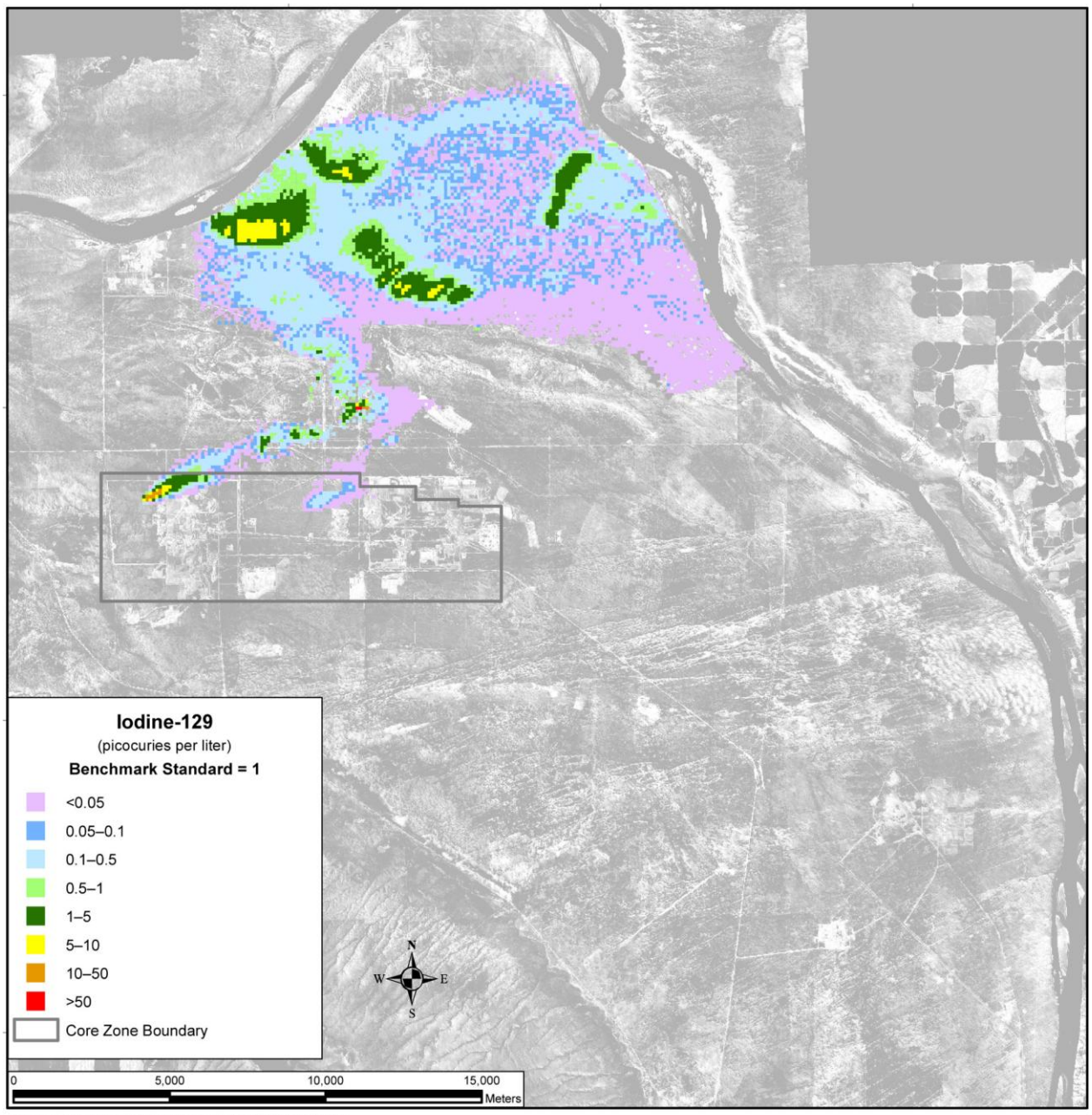
Figure 5–877. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



Note: To convert meters to feet, multiply by 3.281.

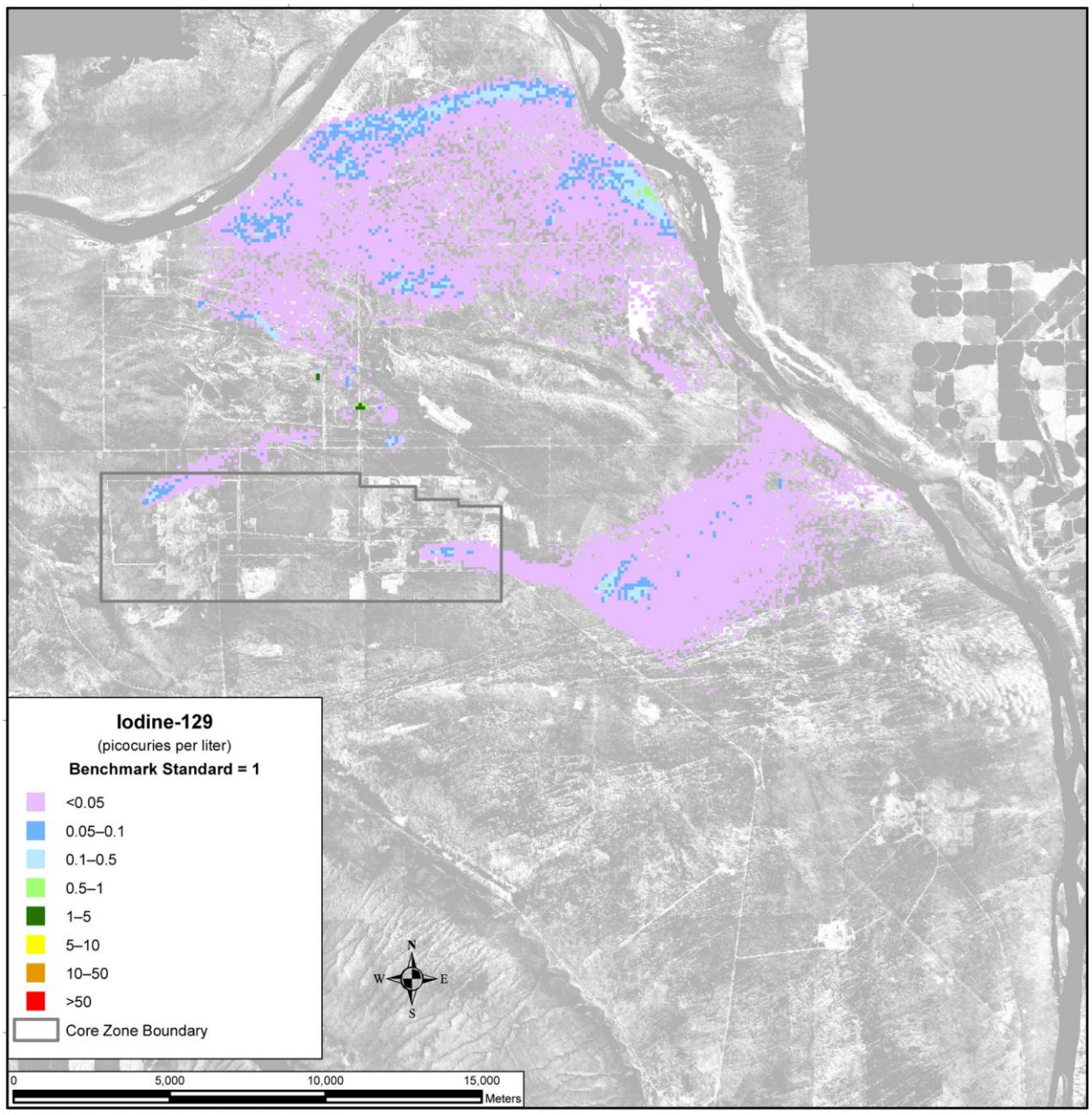
Figure 5–878. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885

Figures 5–879 through 5–881 show iodine-129 released from IDF-East, IDF-West, and the RPPDF with a spatial distribution very similar to the technetium-99 release. However, the CY 3890 iodine-129 release (see Figure 5–879) shows higher relative concentrations (compared with the benchmark concentration) than the technetium-99 release. The areas of high concentrations are in the same locales, but these areas have levels that exceed the benchmark concentration by at least one order of magnitude. The iodine-129 released from IDF-West and the RPPDF has significantly dissipated by CY 7140 (see Figure 5–880). The IDF-West iodine-129 release shows less area in which concentrations are at or above the benchmark concentration than the technetium-99 release. The iodine-129 released from IDF-East in CY 11,885 (see Figure 5–881) shows the same relative spatial distribution as technetium-99, but the areas that approach or exceed the benchmark concentration are significantly smaller.



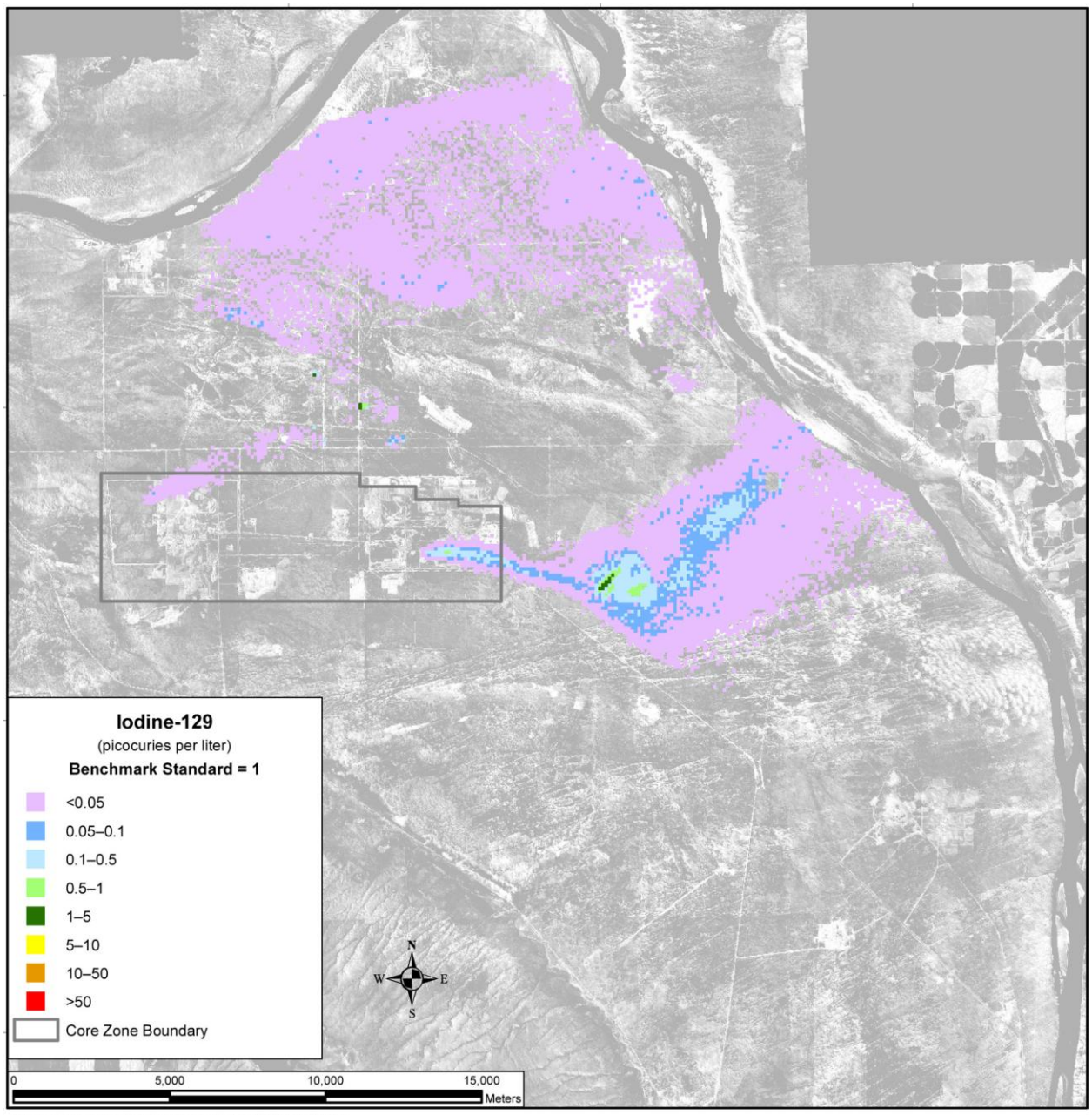
Note: To convert meters to feet, multiply by 3.281.

Figure 5–879. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

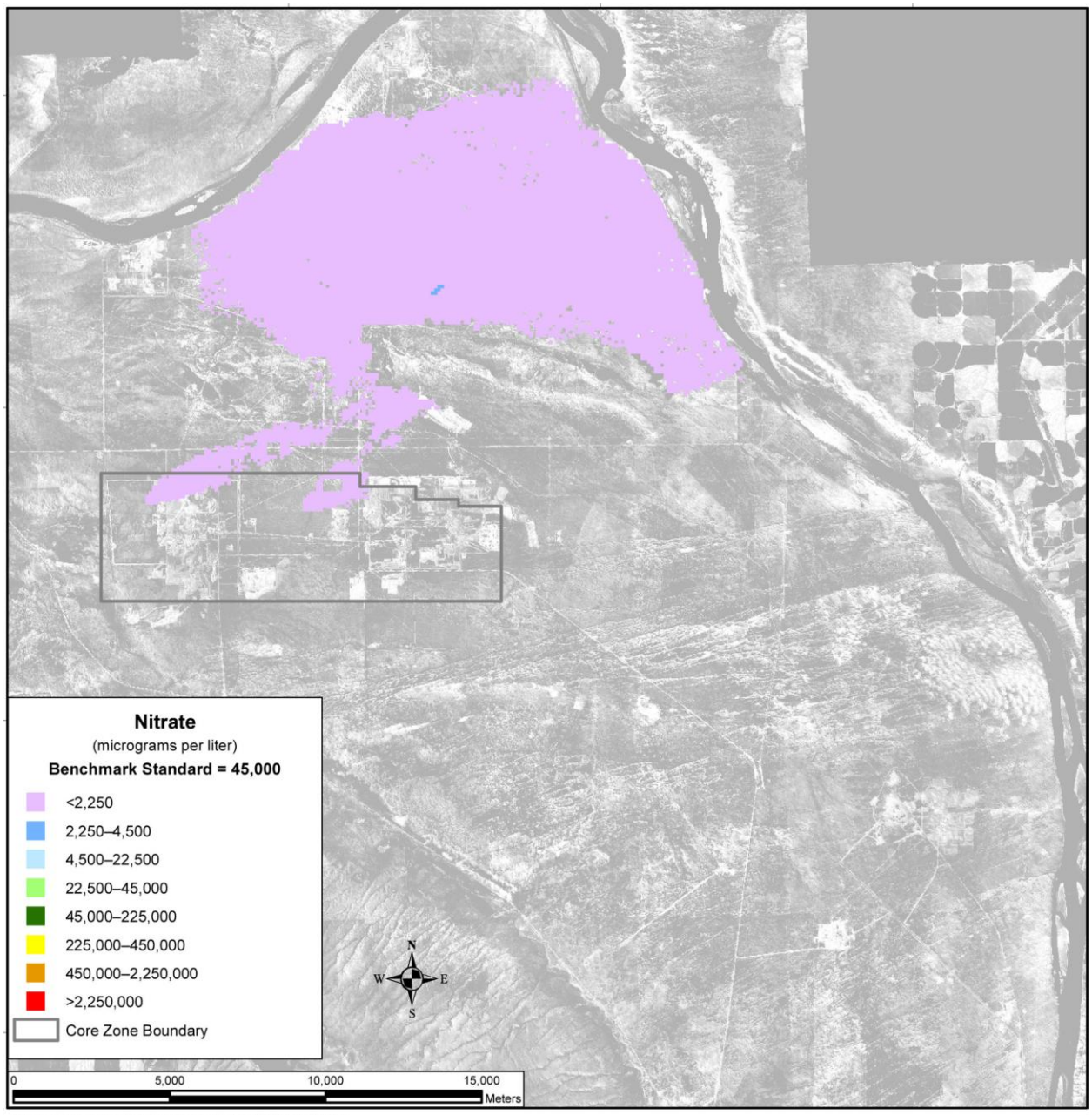
Figure 5–880. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



Note: To convert meters to feet, multiply by 3.281.

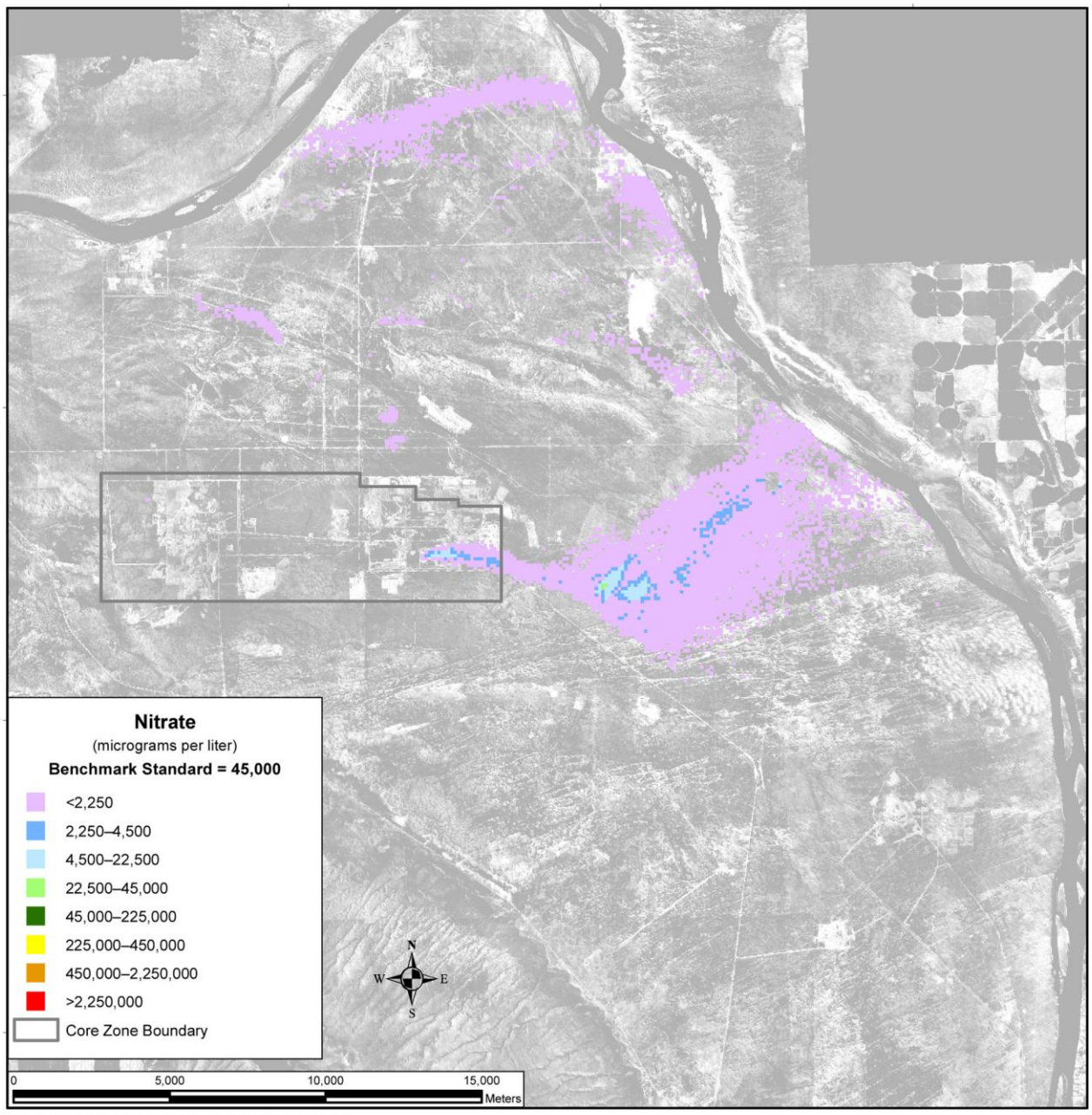
Figure 5–881. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885

The IDF-East, IDF-West, and RPPDF nitrate releases, shown in Figures 5–882 through 5–884, show time and spatial distributions similar to the technetium-99 and iodine-129 releases. However, because the inventory of nitrate is lower than that of technetium-99 and iodine-129, concentrations of nitrate in these distributions are significantly less than the nitrate benchmark concentration. By CY 11,885, most of the groundwater nitrate has dissipated.



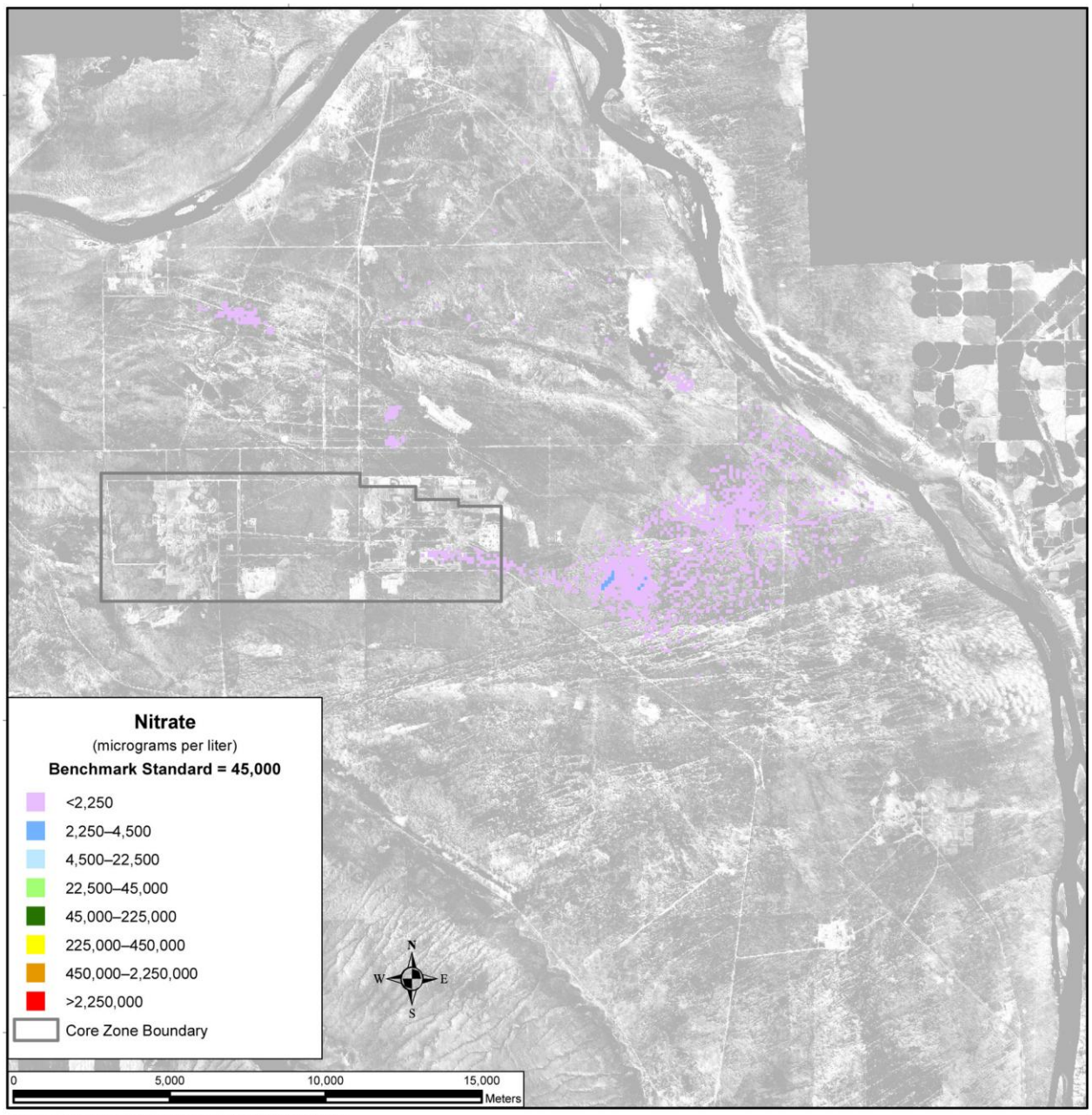
Note: To convert meters to feet, multiply by 3.281.

Figure 5–882. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

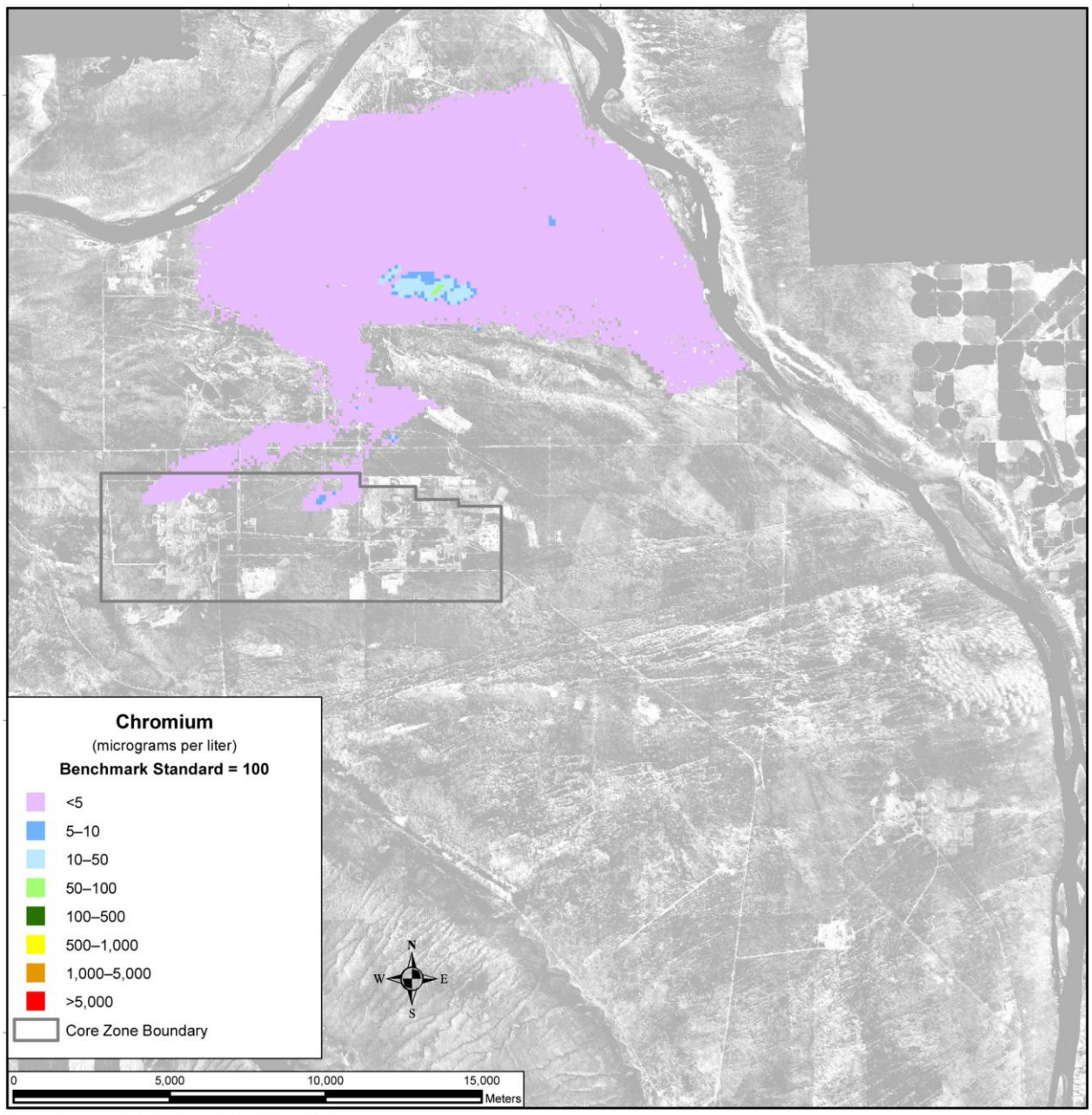
Figure 5–883. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



Note: To convert meters to feet, multiply by 3.281.

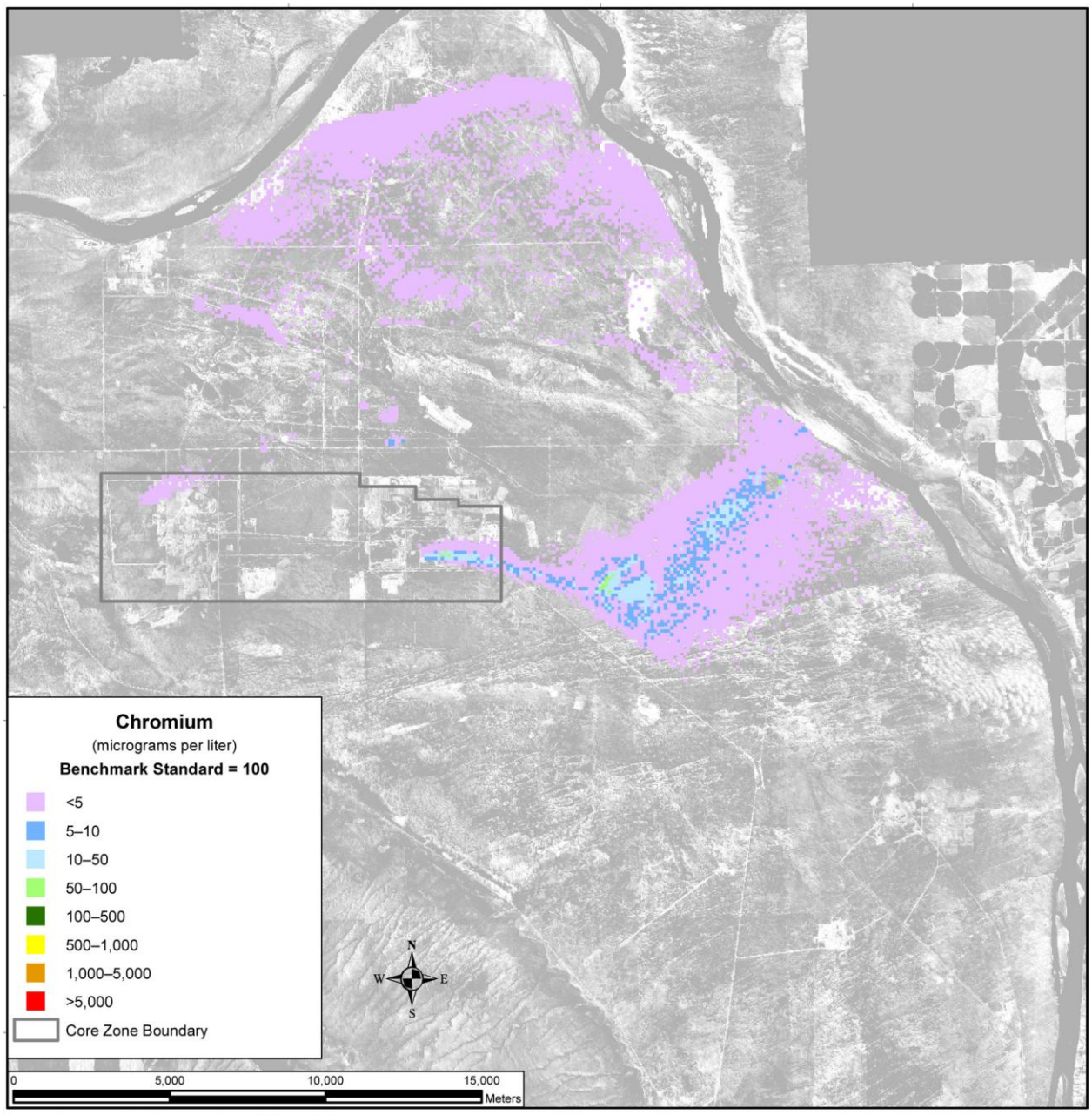
Figure 5–884. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

The initial chromium release time and spatial patterns in CY 3890 are nearly identical to the IDF-West and RPPDF nitrate releases (see Figure 5–885). There are several small areas where the chromium concentration approaches or exceeds its benchmark concentration. Most of the chromium released from IDF-West and the RPPDF has dissipated to the Columbia River by CY 7140 (see Figure 5–886). This figure also shows a significant chromium distribution from IDF-East with small areas that exceed benchmark concentrations. By CY 11,885, the IDF-West and RPPDF chromium has essentially dissipated (see Figure 5–887). However, there is a significant distribution of chromium that extends from the IDF-East release site to the Columbia River. Most of the distribution is well below benchmark concentrations.



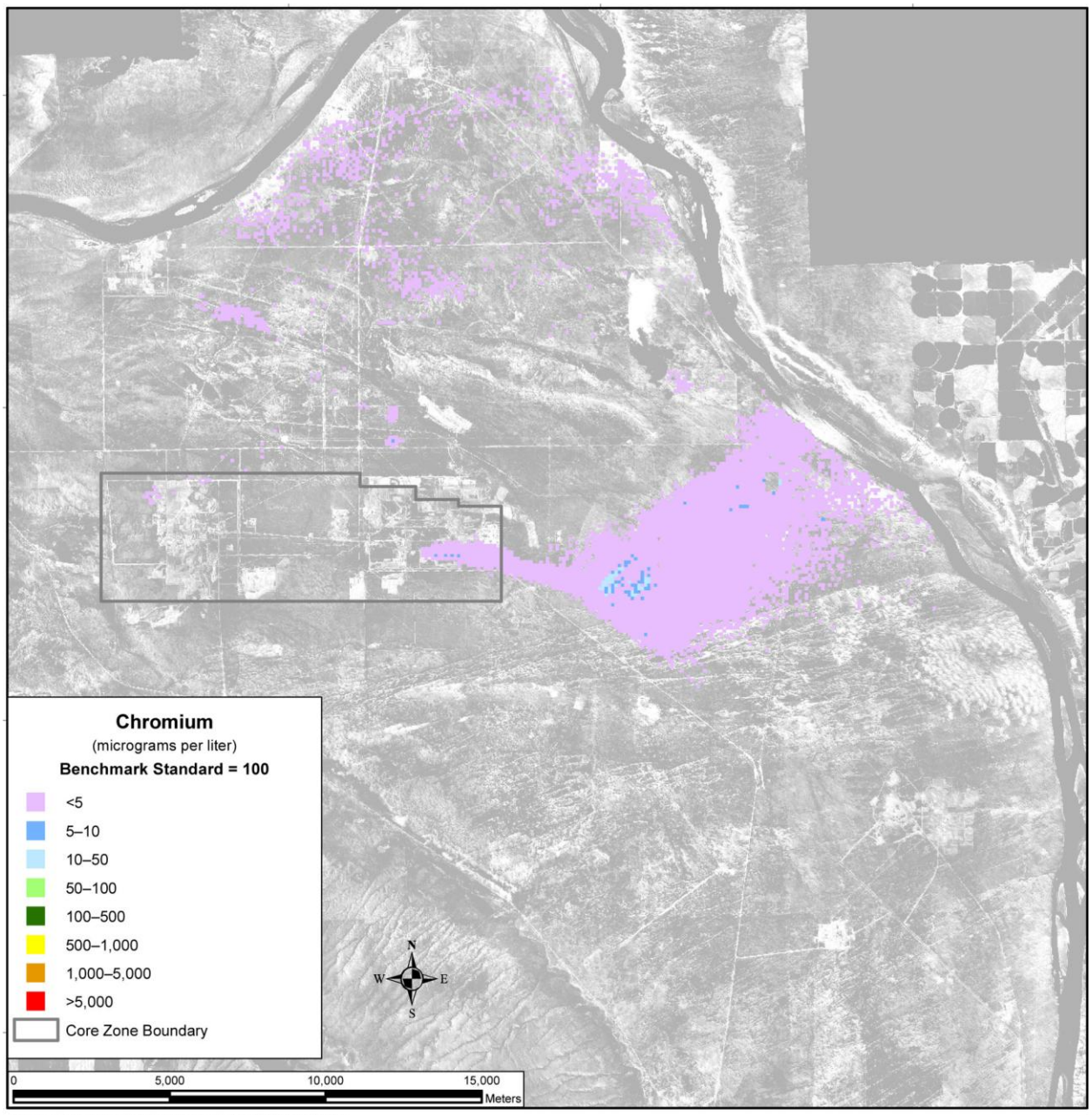
Note: To convert meters to feet, multiply by 3.281.

Figure 5–885. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

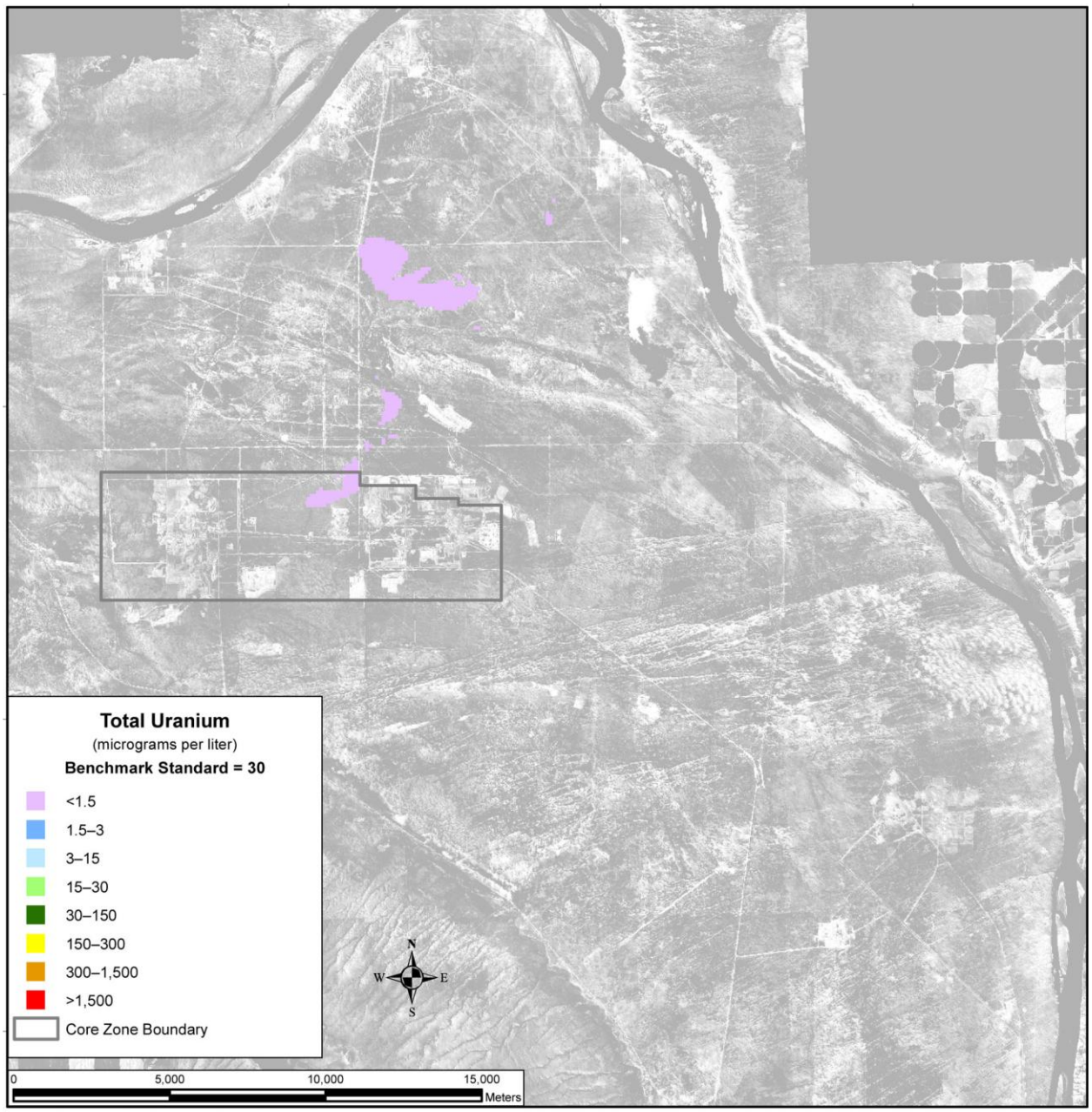
Figure 5–886. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



Note: To convert meters to feet, multiply by 3.281.

Figure 5–887. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885

The total uranium spatial distribution in Figure 5–888 (CY 11,885) shows a plume from the RPPDF. There is no total uranium release from IDF-East. The total uranium concentration remains well below the benchmark concentration over the period of analysis.



Note: To convert meters to feet, multiply by 3.281.

Figure 5–888. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, Spatial Distribution of Groundwater Total Uranium Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-E, in general, the inventories remaining in IDF-East, IDF-West, and the RPPDF, which are available for release to the environment at the start of the post-disposal period, are predominant contributors. The releases from IDF-West and the RPPDF occur earlier and dissipate earlier than releases from IDF-East.

By the end of this analysis period (CY 11,885), the chromium and nitrate distributions have largely dispersed below their benchmark concentrations. Significant spatial distributions of technetium-99 and iodine-129 remain. Most of the distribution area has concentrations below benchmark levels, but there are some small areas in which technetium-99 and iodine-129 concentrations exceed benchmark levels in CY 11,885. The released iodine-129, which occurs at higher concentration levels relative to its benchmark than technetium-99, dissipates much more quickly than technetium-99.

For total uranium, limited mobility is an important factor governing the timeframe and scale of groundwater impacts. The concentrations of total uranium do not exceed the benchmark level at the IDF-West barrier, RPPDF barrier, IDF-East barrier, Core Zone Boundary, or Columbia River nearshore over this period of analysis. However, the spatial distribution of total uranium exists through the end of the analysis period (CY 11,885). Although the concentrations of total uranium remain six orders of magnitude smaller than the benchmark concentration during the analysis period, the trend appears to show a continuing increase through the end of the analysis period.

5.3.1.3.1.6 Disposal Group 1, Subgroup 1-F

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, was designed to accommodate the disposal of waste generated under Tank Closure Alternative 5 and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Tank closure waste would be converted to IHLW, ILAW glass, bulk vitrification glass, cast stone waste, and sulfate grout.

For the long-term groundwater impacts analysis, two major periods were identified for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, as follows:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East and IDF-West and continue through CY 2050, when these disposal facilities would be operationally closed. During the disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2051 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in IDF-East and IDF-West would become available for release to the environment, and it was assumed for analysis purposes that barriers would be emplaced over the facilities to limit infiltration during the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, is focused on the following COPC drivers:

- Radiological risk drivers: iodine-129 and technetium-99
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, fluoride, and nitrate

The COPC drivers for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. The radiological risk drivers listed above account for essentially

100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard drivers above account for over 99 percent of the chemical hazard associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, chromium, fluoride, nitrite, and acetonitrile) are all mobile (i.e., move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, in terms of the total amount of COPCs released from IDF-East, IDF-West, and the RPPDF to the vadose zone, groundwater, and the Columbia River during the 10,000-year period of analysis. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over 10 orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

Figure 5–889 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–890, the chemical hazard drivers. The inventories in the seven waste forms are a major factor in the release quantities to the vadose zone. Cast stone waste is the predominant vadose zone source of technetium-99 (82 percent), with the remainder coming largely from bulk vitrification glass (12 percent) and some from tank closure secondary waste (4 percent) and ETF-generated secondary waste (1 percent). The vadose zone iodine-129 is from ETF-generated secondary waste (89 percent) and cast stone waste (7 percent), with some from tank closure secondary waste (3 percent). Cast stone waste is the predominant vadose zone source of chromium (73 percent), with some from sulfate grout waste (26 percent). The nitrate is from ETF-generated secondary waste (56 percent) and cast stone waste (44 percent). Fluoride is not released from IDF-East.

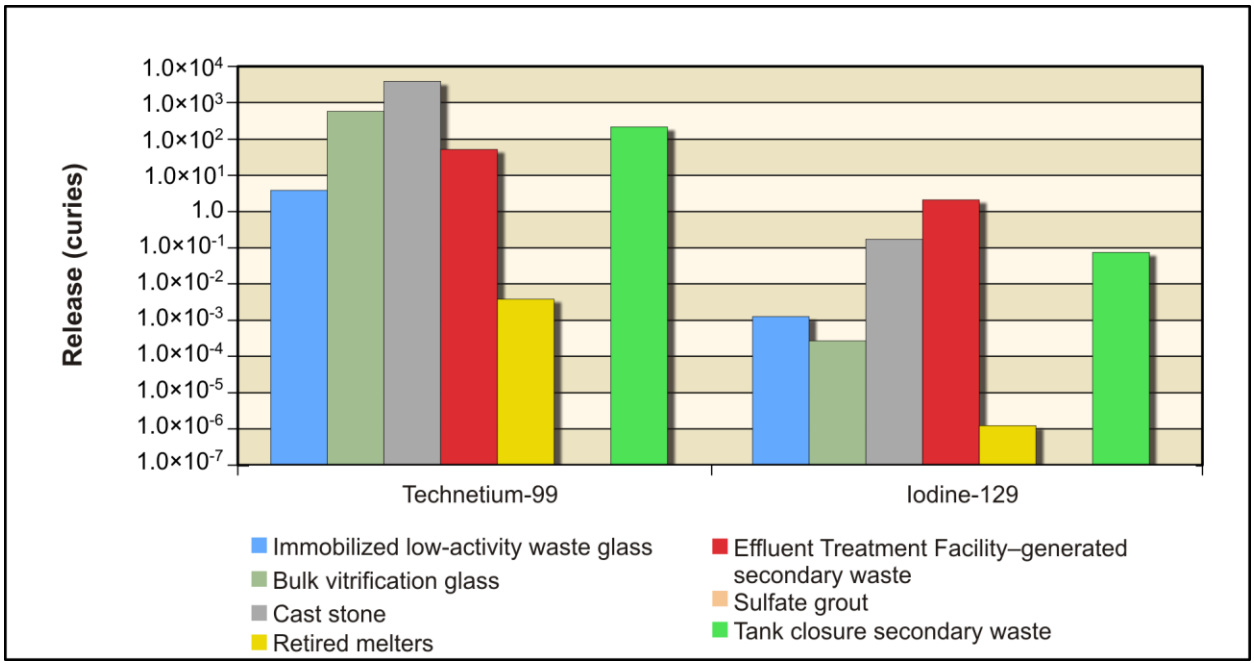


Figure 5–889. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

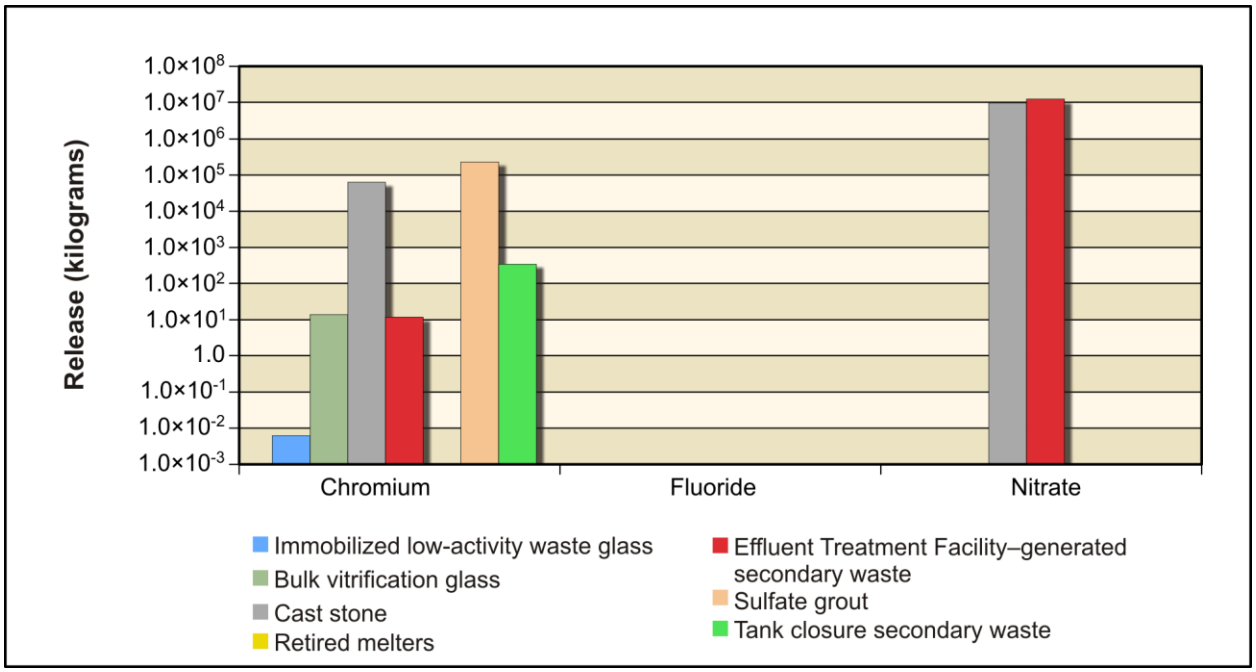


Figure 5–890. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–891 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–892, the chemical hazard drivers. In addition to the waste form inventory, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. The vadose zone releases some technetium-99 (52 percent) and iodine-129 (43 percent) to groundwater. Nearly all (99 percent) of the vadose zone chromium and nitrate are released to groundwater.

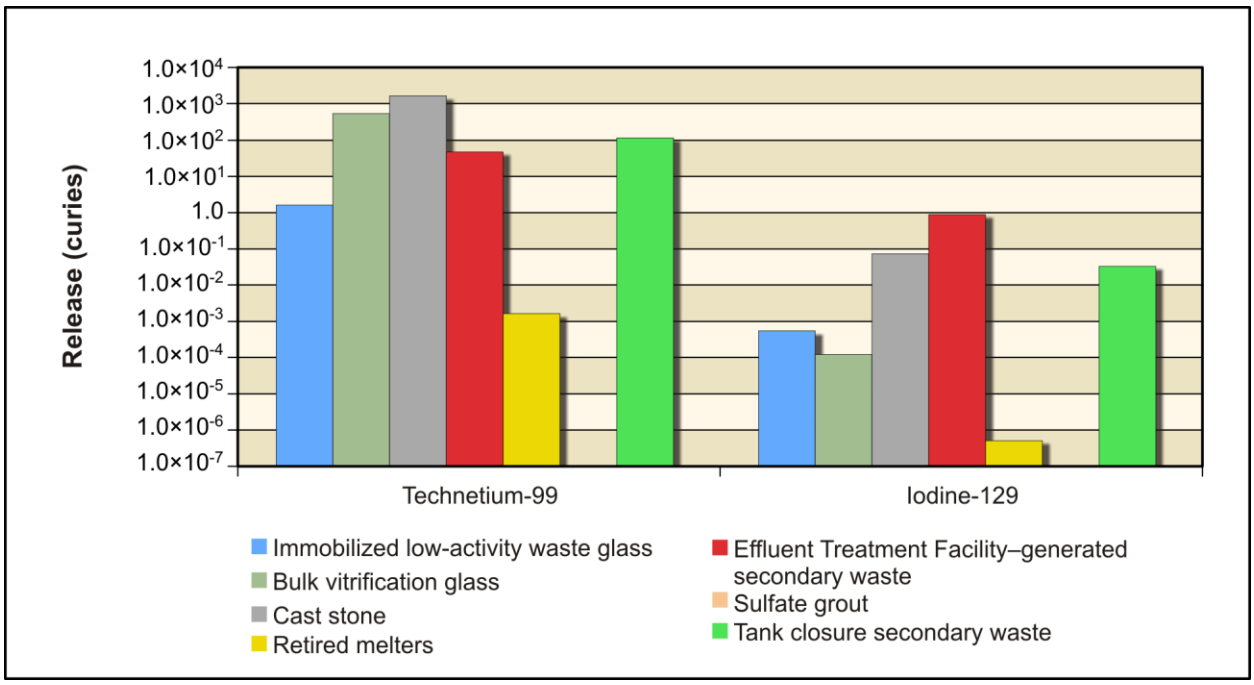


Figure 5–891. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

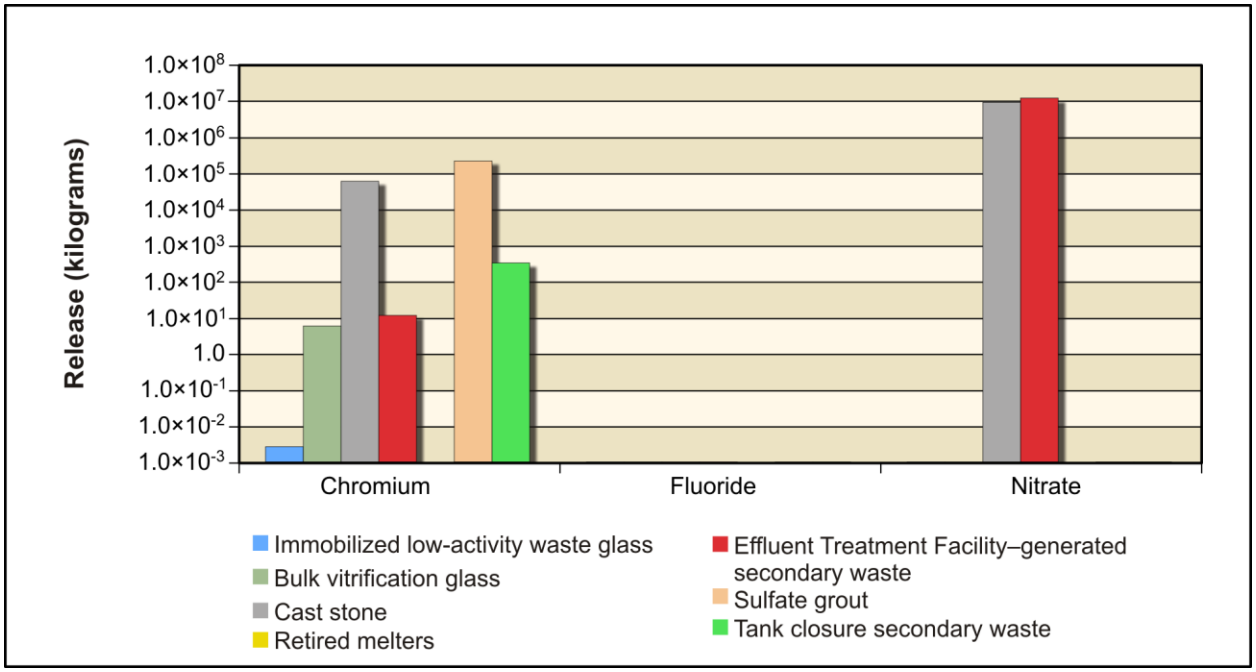


Figure 5–892. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–893 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–894, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. The groundwater releases most of its technetium-99 (97 percent), iodine-129 (96 percent), chromium (greater than 99 percent), and nitrate (greater than 99 percent) to the Columbia River.

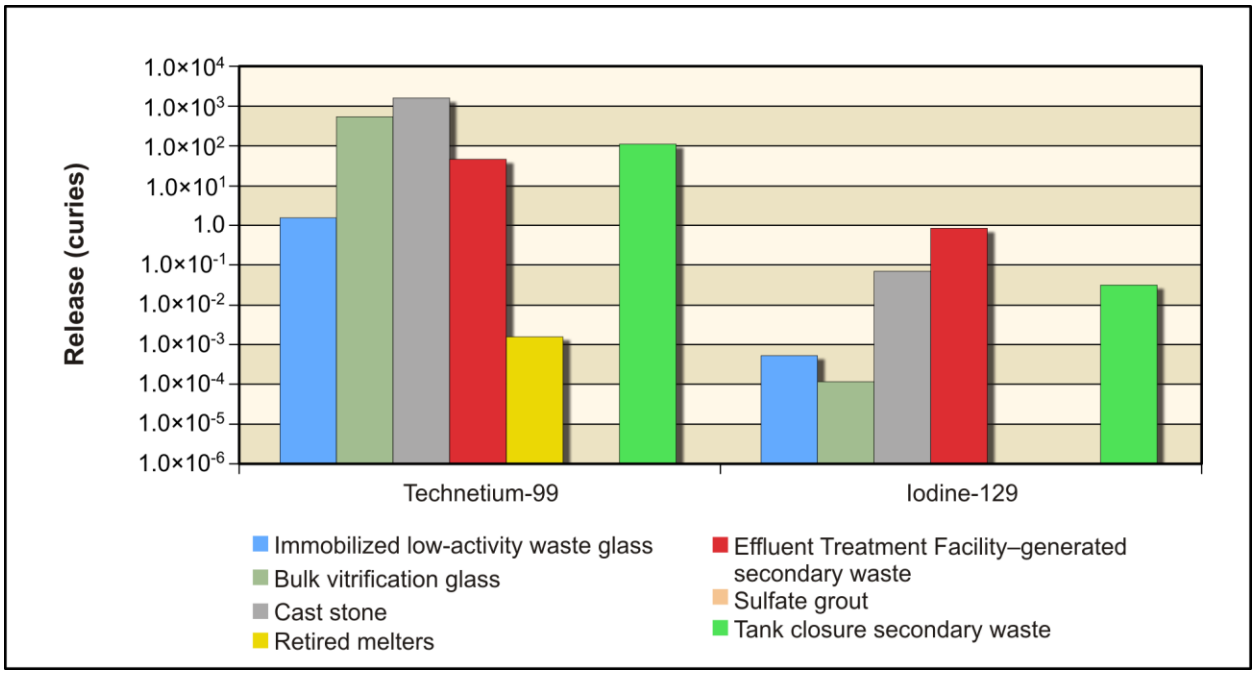


Figure 5–893. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

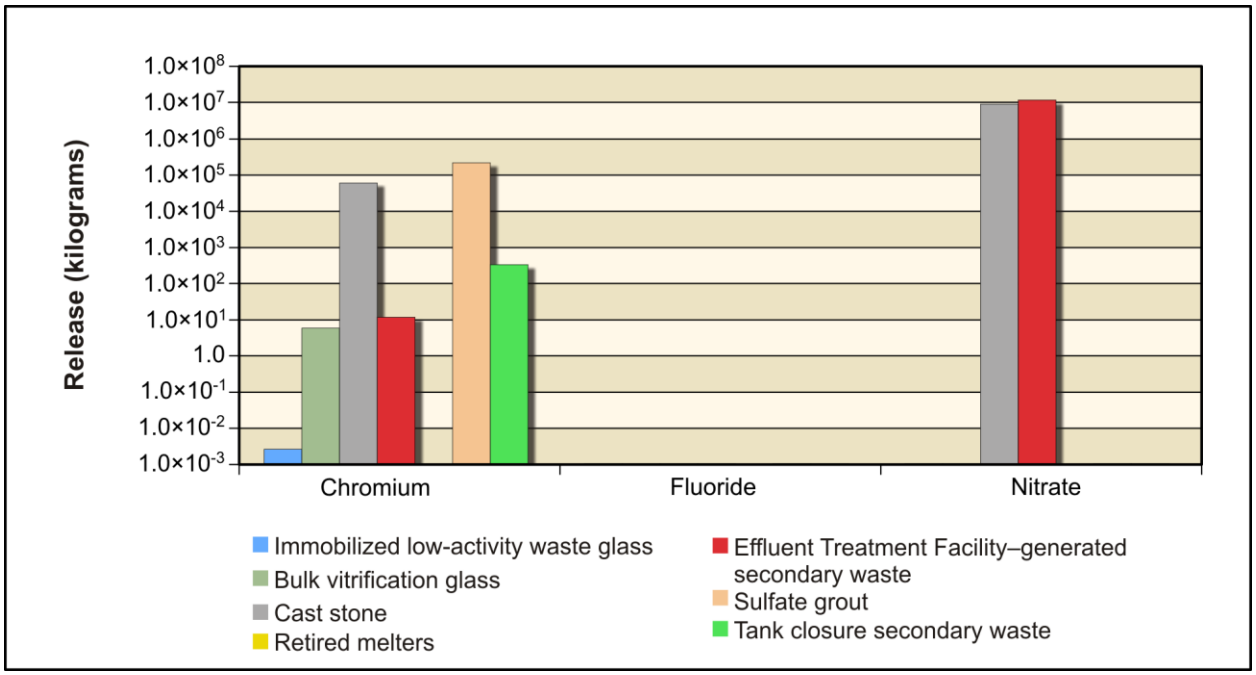


Figure 5–894. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

Overall, almost all of the IDF-East vadose zone chromium (99 percent) and nitrate (99 percent), as well as some of the vadose zone technetium-99 (51 percent) and iodine-129 (41 percent), reach the Columbia River over the period of analysis.

200-West Area Integrated Disposal Facility

Three subtotals are plotted in Figures 5–895 through 5–900, representing releases from IDF-West, which include FFTF Decommissioning Alternative 3 waste, waste management secondary waste and onsite waste, and offsite waste.

Figure 5–895 shows the estimated release from IDF-West to the vadose zone of the radiological risk drivers and Figure 5–896, the chemical hazard drivers. The inventories in the three waste forms are a major factor in the release quantities to the vadose zone. The predominant source of technetium-99 (98 percent) and iodine-129 (greater than 99 percent) released to the vadose zone is offsite waste. All (greater than 99 percent) of the nitrate and fluoride that is released to the vadose zone is from waste management secondary waste. The chromium released to the vadose zone is from waste management secondary waste and onsite waste (69 percent) and offsite waste (31 percent).

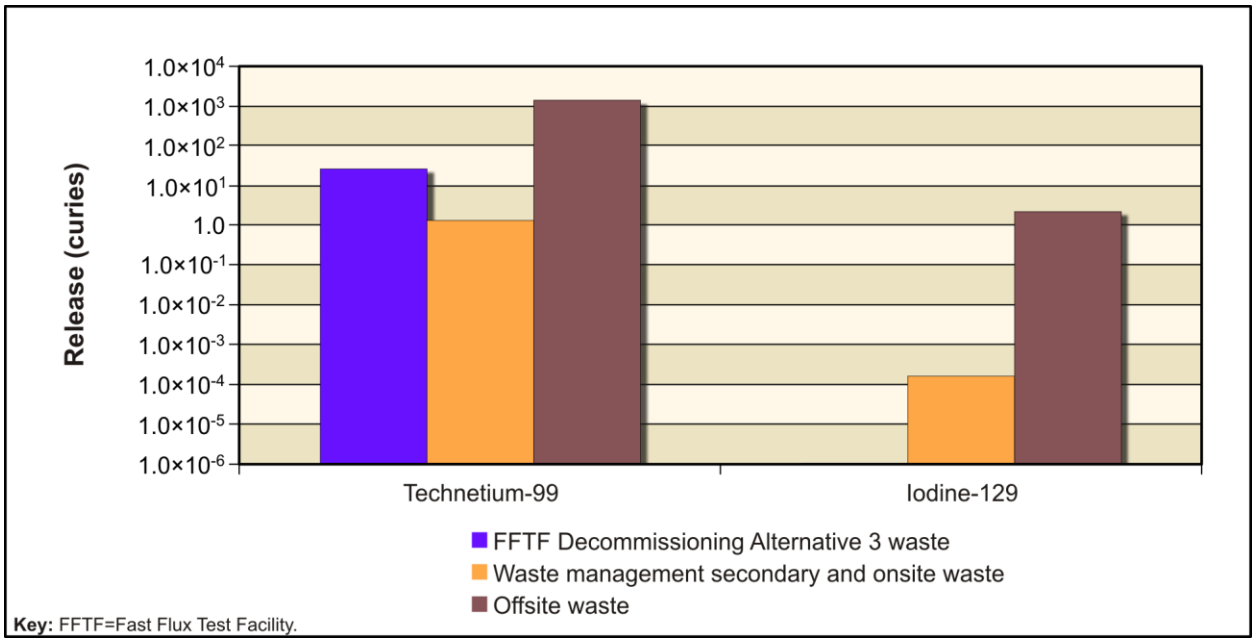


Figure 5–895. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

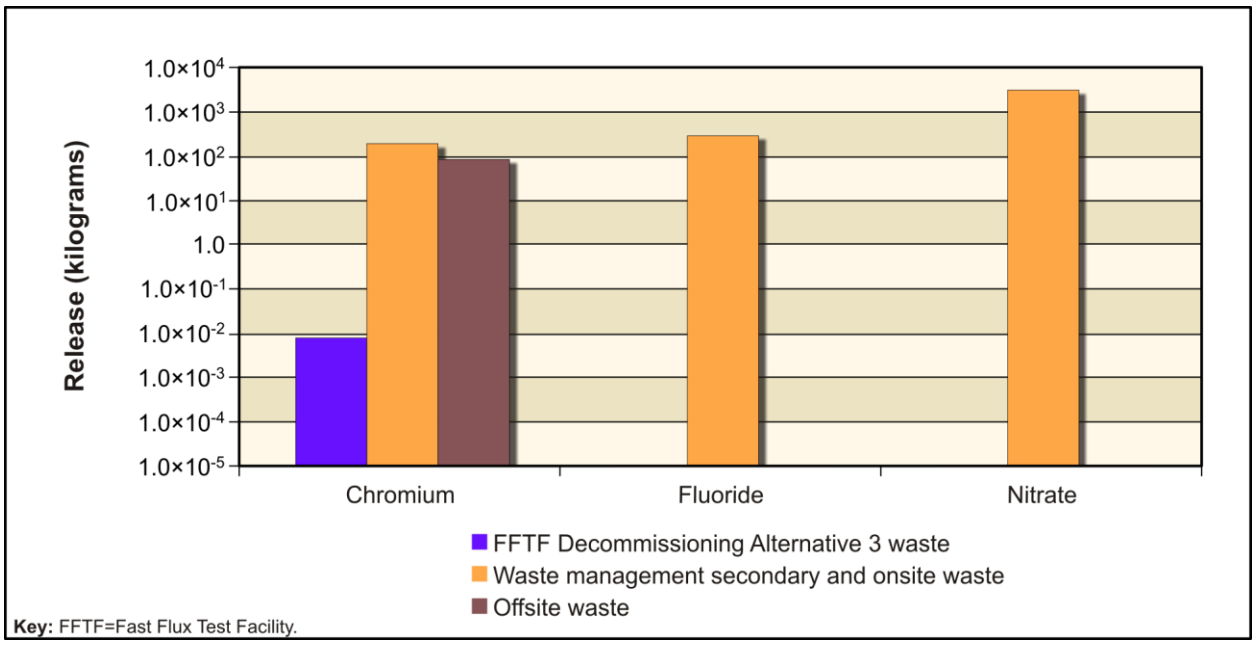


Figure 5–896. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Chemical Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

Figure 5–897 shows the estimated release from IDF-West to groundwater of the radiological risk drivers and Figure 5–898, the chemical hazard drivers. In addition to the waste form inventory, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. Most of the IDF-West vadose zone technetium-99 (97 percent), iodine-129 (97 percent), chromium (99 percent), nitrate (greater than 99 percent), and fluoride (greater than 99 percent) are released to groundwater during the period of analysis.

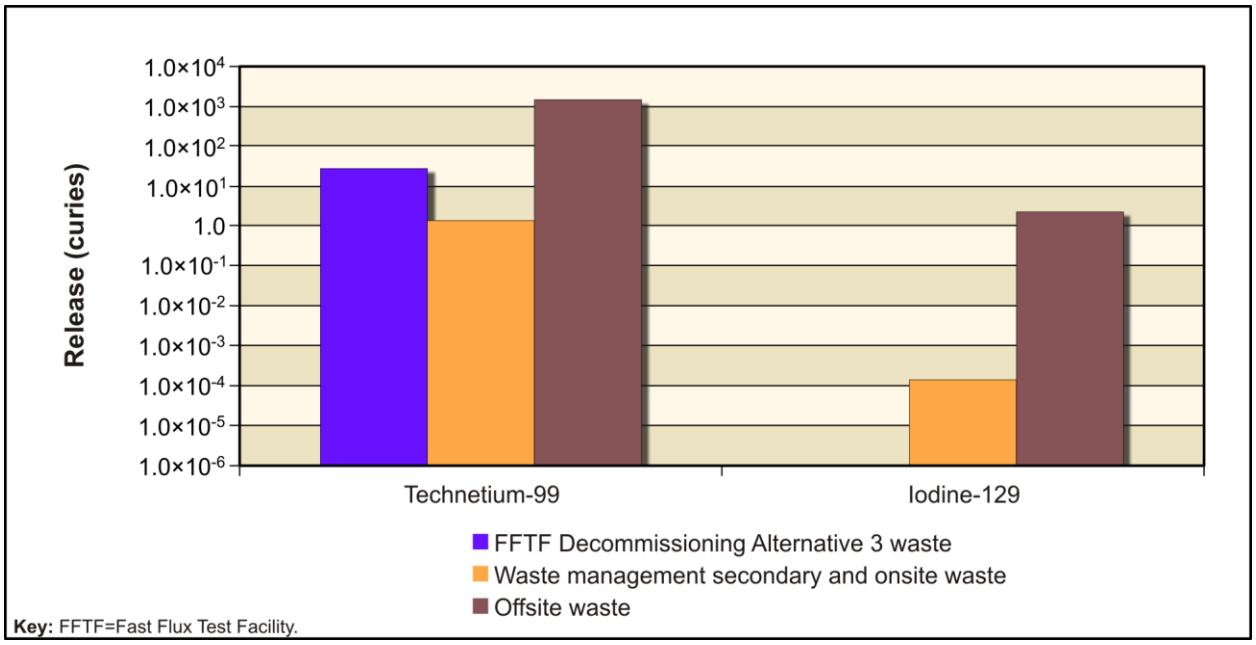


Figure 5–897. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Groundwater

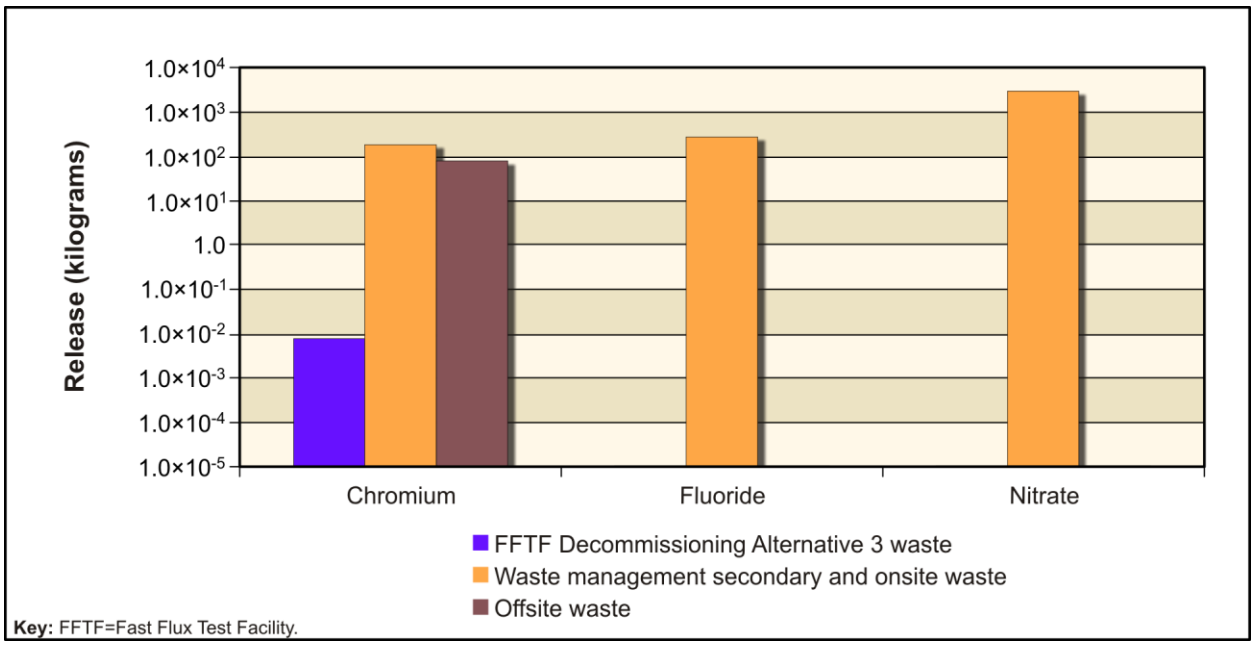


Figure 5–898. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Chemical Releases from 200-West Area Integrated Disposal Facility to Groundwater

Figure 5–899 shows the estimated release from IDF-West to the Columbia River of the radiological risk drivers and Figure 5–900, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Nearly all (99–100 percent) of the IDF-West groundwater technetium-99, iodine-129, chromium, nitrate, and fluoride are released to the Columbia River during the period of analysis.

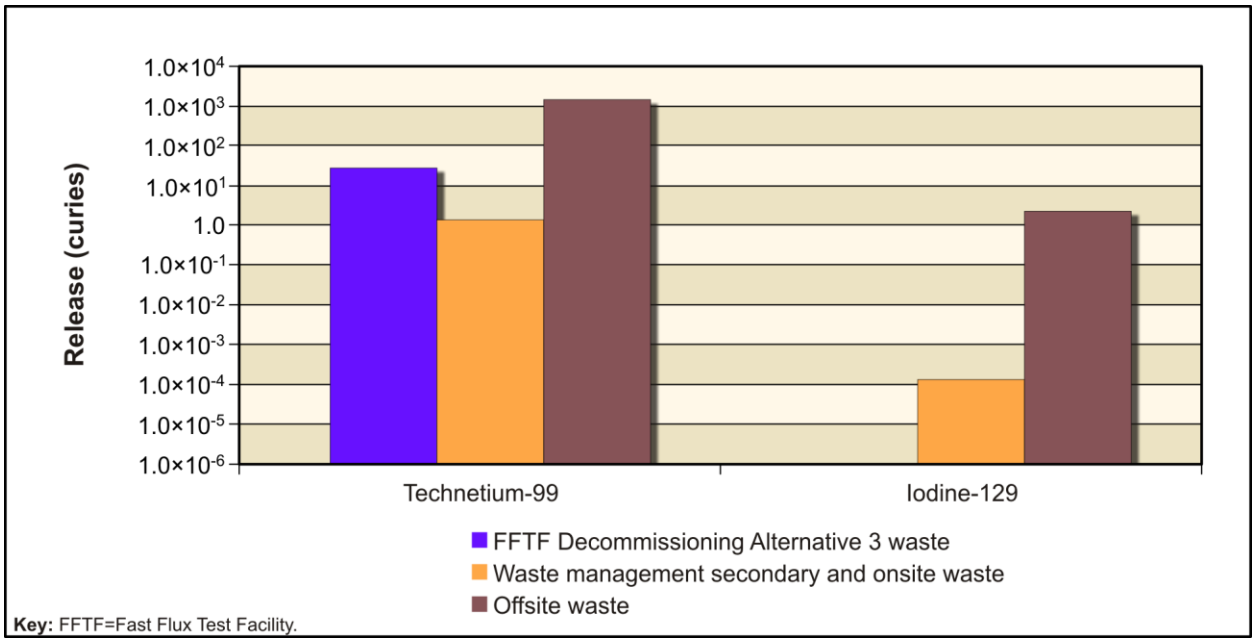


Figure 5–899. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Columbia River

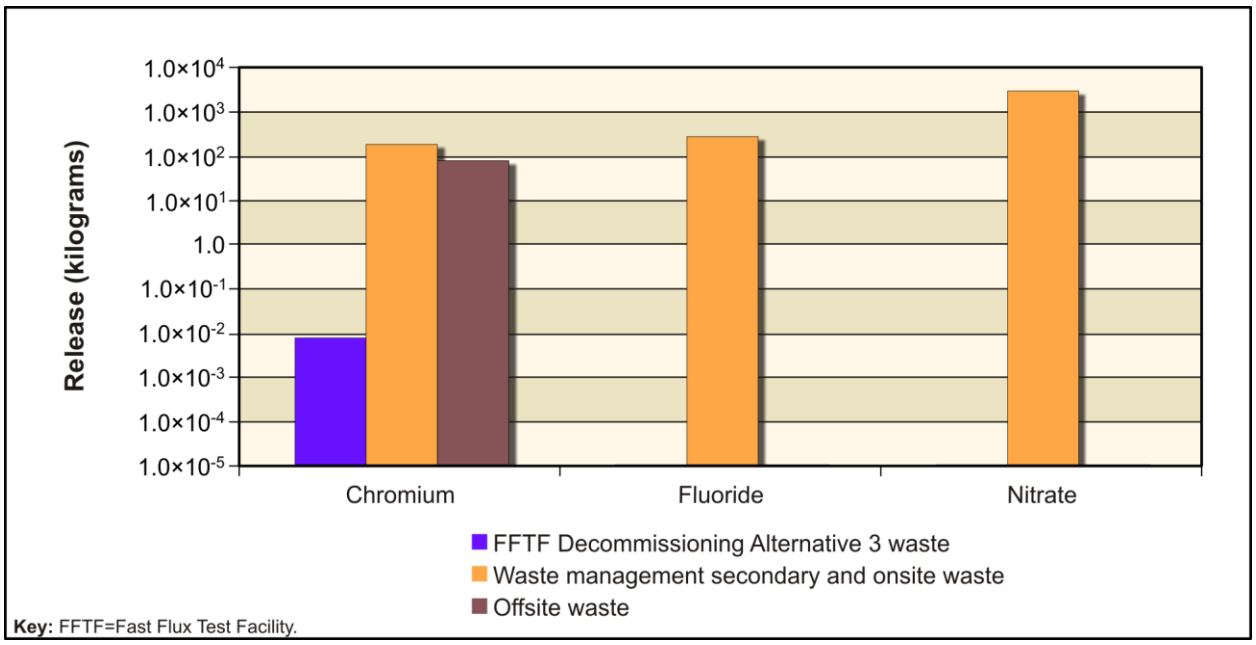


Figure 5–900. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Chemical Releases from 200-West Area Integrated Disposal Facility to Columbia River

Overall, most (97–99 percent) of the IDF-West vadose zone technetium-99, iodine-129, chromium, nitrate and fluoride reach the Columbia River during the period of analysis.

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, in terms of groundwater concentration versus time at the Core Zone Boundary and the Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. The benchmark concentration of each radionuclide and chemical is also shown. Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations. Table 5–111 shows maximum concentrations in groundwater. Exceedances of the respective benchmark concentrations occur at the IDF-East barrier, IDF-West barrier, Core Zone Boundary, and Columbia River nearshore, where concentrations of technetium-99 and iodine-129 exceed the benchmark. Chromium exceeds the benchmark concentration only at the IDF-East barrier. No other exceedances of benchmark concentrations occur for any of the other COPC drivers.

Table 5–111. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Maximum COPC Concentrations in the Peak Year at IDF-East, IDF-West, and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	IDF-West	RPPDF	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	**1,380** (8878)	**13,200** (3818)	N/A	**1,370** (3859)	**1,670** (3920)	900
Iodine-129	0.8 (9723)	**20.6** (3794)	N/A	**2.1** (3937)	**2.4** (3872)	1
Chemical (micrograms per liter)						
Acetonitrile	3 (8858)	0 (1940)	N/A	1 (8981)	1 (8696)	100
Chromium	**295** (8882)	1 (3813)	N/A	78 (9057)	60 (8241)	100
Fluoride	0 (1940)	1 (4014)	N/A	0 (3937)	0 (4307)	4,000
Nitrate	19,400 (8206)	7 (3927)	N/A	6,250 (7810)	4,140 (7984)	45,000

Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

Figures 5–901 through 5–904 show concentration versus time for technetium-99, iodine-129, chromium, and nitrate. Figure 5–901 shows that, at the onset of the releases from IDF-East and IDF-West, there is a technetium-99 release peak (lasting about 1,500 years) that exceeds the benchmark concentration by about one order of magnitude at the IDF-West barrier. Technetium-99 concentrations also exceed the benchmark concentration by less than one order of magnitude at the Core Zone Boundary and Columbia River nearshore for a shorter period of time. The technetium-99 concentrations at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore then decrease below the benchmark concentration and remain at approximately one to two orders of magnitude below the benchmark for the remainder of the 10,000-year simulation period. Technetium-99 concentrations at the IDF-East barrier begin to increase later in the simulation, around CY 4500. Concentrations rise continuously and reach or exceed the technetium-99 benchmark value at about CY 8000 and remain constant at less than one order of magnitude above the benchmark until the end of the simulation (CY 11,940).

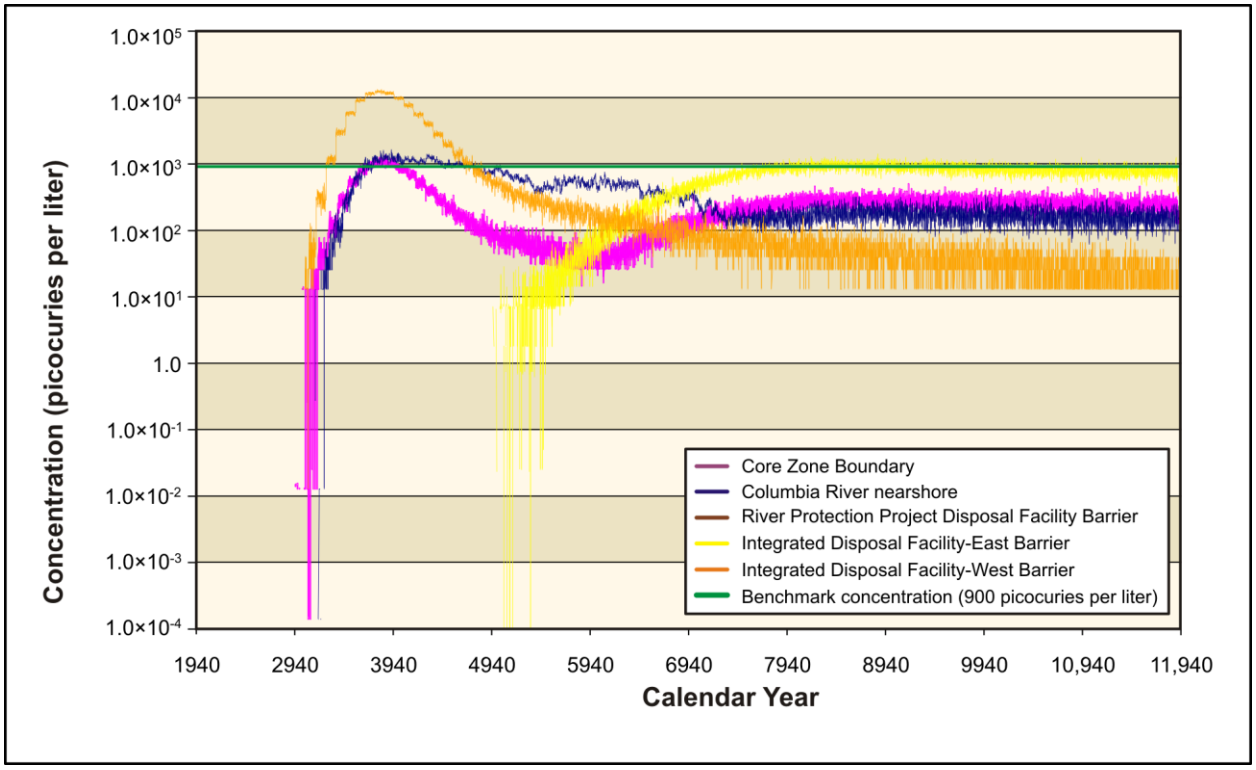


Figure 5–901. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Technetium-99 Concentration Versus Time

The IDF-West barrier, IDF-East barrier, Core Zone Boundary, and Columbia River nearshore show similar concentration peaks at the onset of the iodine-129 release (see Figure 5–902). The IDF-West barrier concentration peaks at between one and two orders of magnitude above the benchmark, whereas the Core Zone Boundary concentration peaks at less than one order of magnitude above the benchmark concentration. The Columbia River nearshore concentration peaks just above the benchmark concentration, but below one order of magnitude. All concentrations then continue on a slow decline that brings them to about one order of magnitude below the benchmark concentration for the latter half of the analysis period.

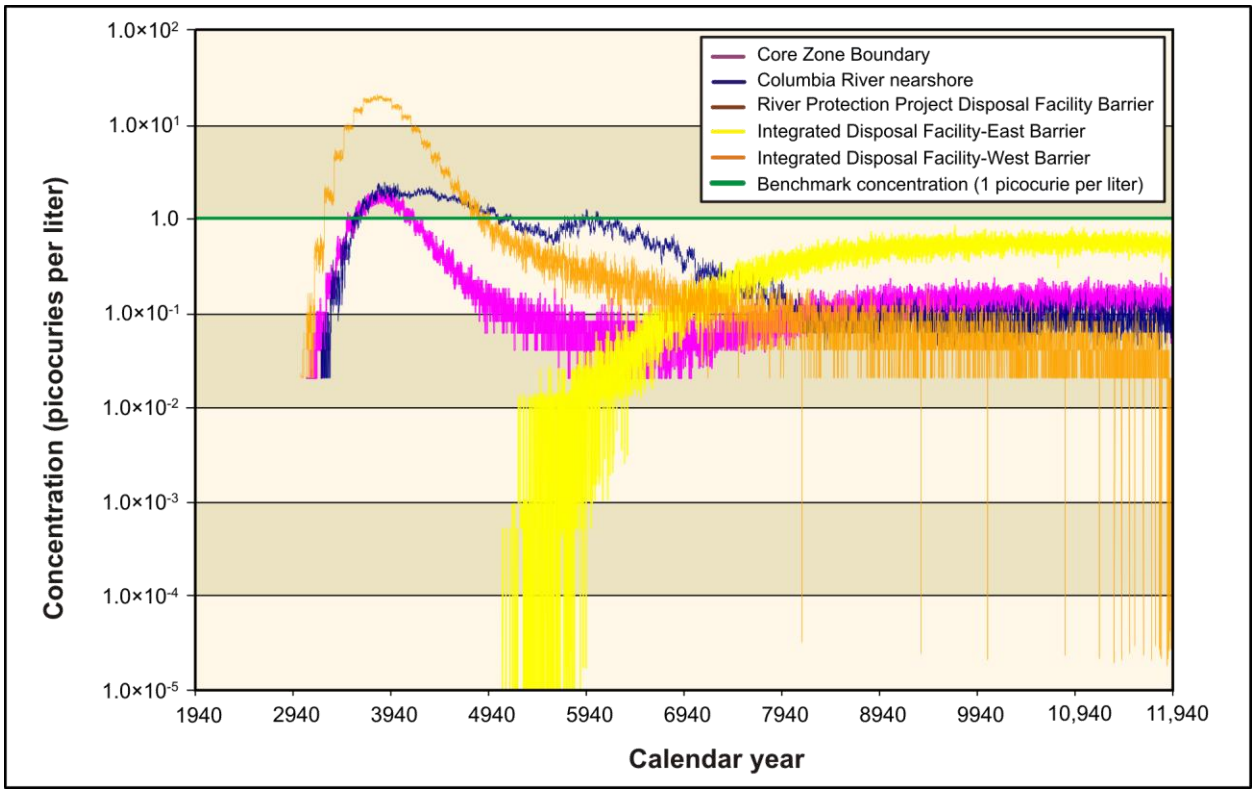


Figure 5–902. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Iodine-129 Concentration Versus Time

Figures 5–903 and 5–904 also show the initial increase in the IDF-West, Core Zone Boundary, and Columbia River nearshore chromium and nitrate. The chromium and nitrate concentrations at the Core Zone Boundary and Columbia River nearshore show a second, broader increase that extends over about two-thirds of the analysis period. The nitrate concentrations are always less than one order of magnitude from the benchmark concentration. The chromium concentrations (at the Core Zone Boundary and Columbia River nearshore) approach within one order of magnitude of the benchmark concentration for most of the analysis period. Chromium and nitrate concentrations at the IDF-West barrier do not show the second peak; rather, the concentrations decline continuously through the 10,000-year simulation period. Chromium and nitrate concentrations at the IDF-East barrier begin the characteristic rise at about CY 4500. Chromium concentrations exceed the benchmark concentration from about CY 7000 until about CY 10,000. Nitrate concentrations remain about one order of magnitude below the benchmark value over the same time period.

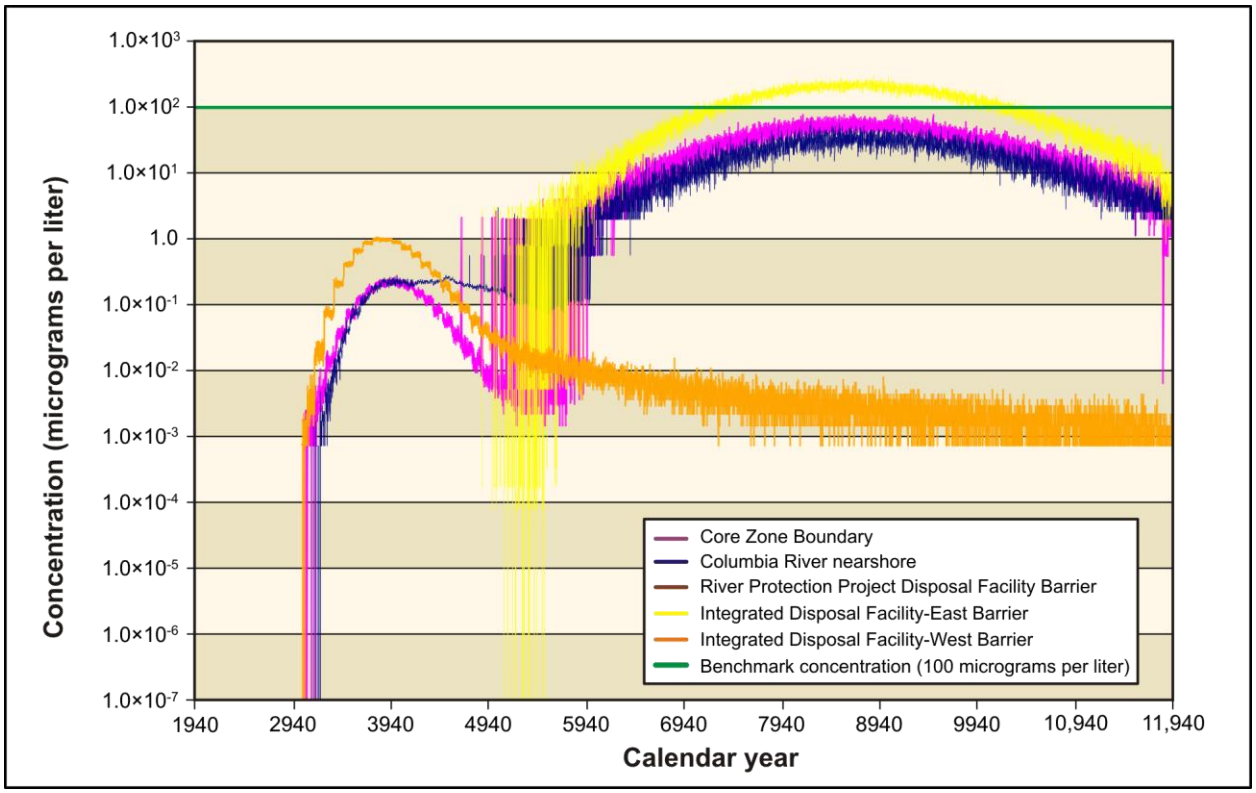


Figure 5–903. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Chromium Concentration Versus Time

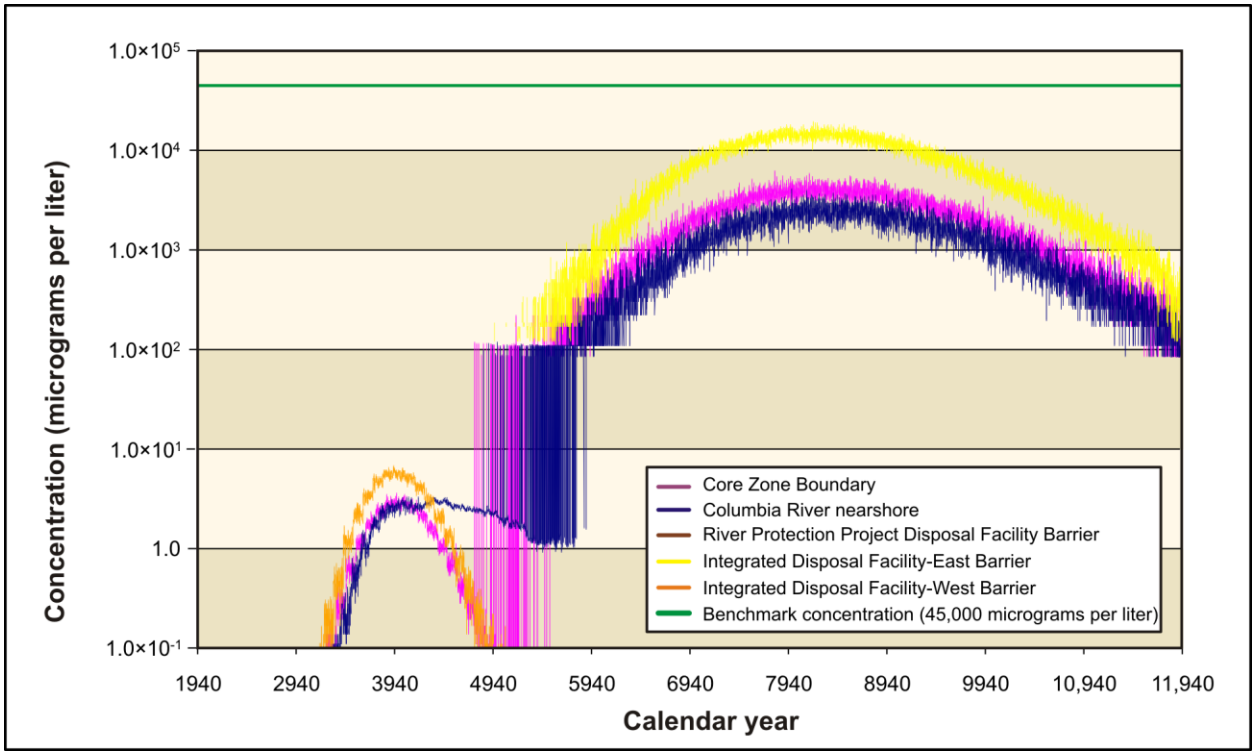


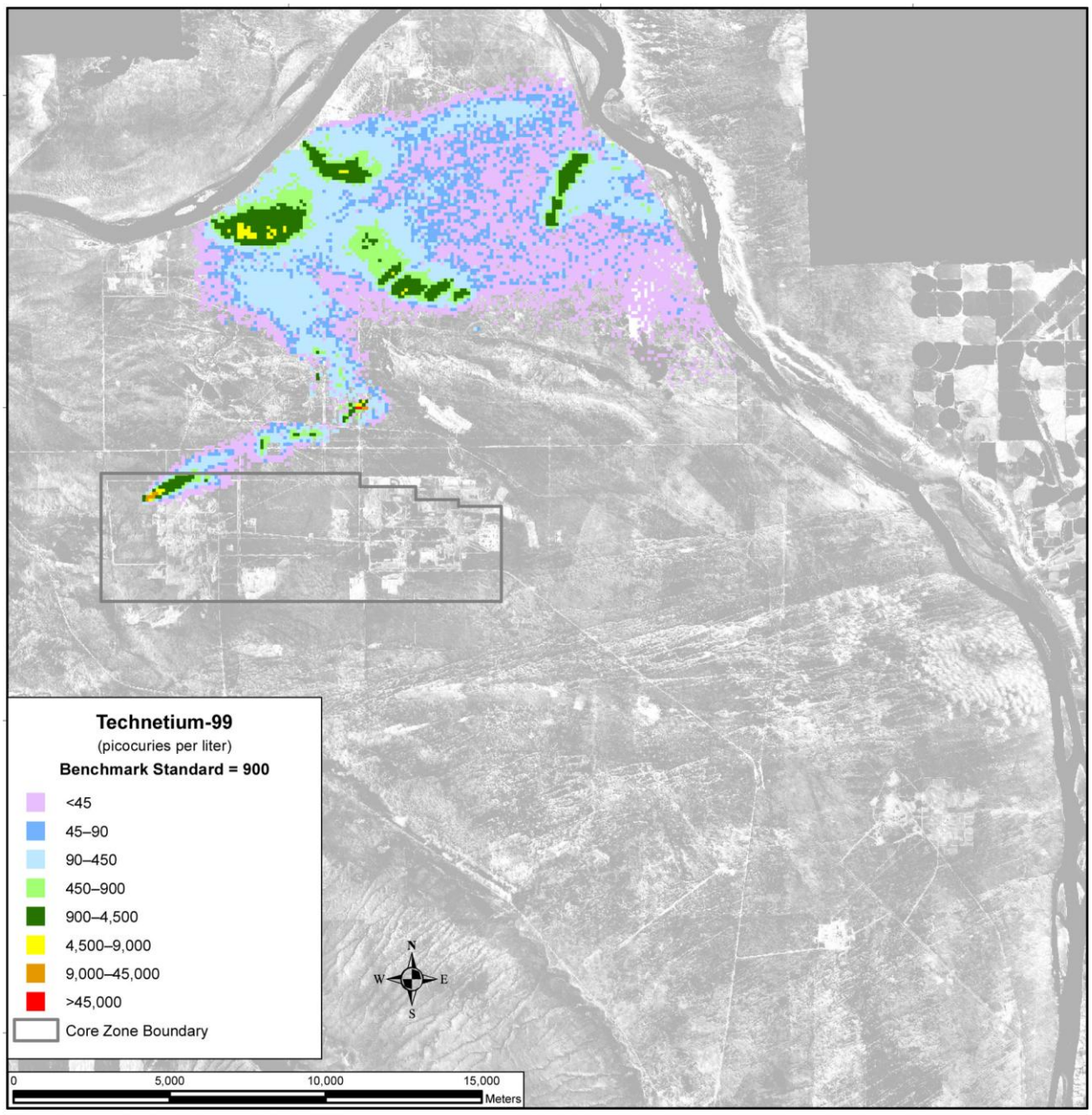
Figure 5–904. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Nitrate Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated by the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations.

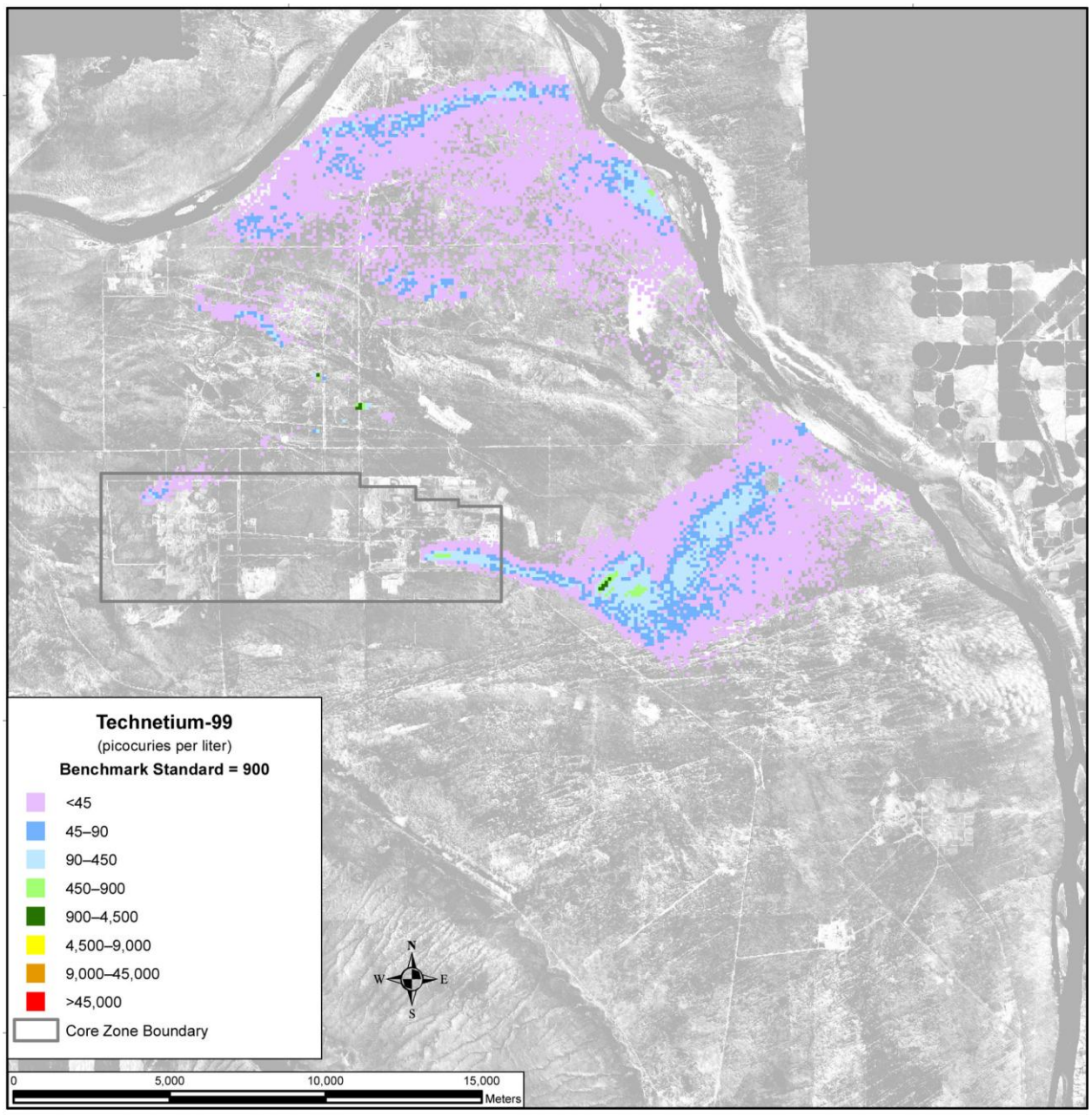
Figures 5–905 through 5–916 show concentration distributions in CYs 3890, 7140, and 11,885 for technetium-99, iodine-129, nitrate, and chromium. The groundwater releases from IDF-West extend north from the release site within the Core Zone to the Columbia River nearshore, with the distribution remaining in a fairly narrow channel (Gable Gap) until about halfway to the Columbia River nearshore. The IDF-East releases remain in a relatively narrow channel until they reach about the one-quarter distance point to the Columbia River, where they broaden and continue to the Columbia River nearshore. For technetium-99, iodine-129, nitrate, and chromium, the IDF-West releases occur earlier and dissipate sooner than those from IDF-East.

Figure 5–905 shows that the technetium-99 release from IDF-West exceeds its benchmark concentration by several orders of magnitude within the Core Zone and in several areas near the Columbia River nearshore in CY 3890. This figure shows no technetium-99 from IDF-East at this time. Figure 5–906 shows that the IDF-West technetium-99 plume has mostly dissipated by CY 7140. The technetium-99 IDF-East release is shown with concentrations that are mostly lower than the technetium-99 benchmark concentration. Figure 5–907 shows that the IDF-West groundwater technetium-99 continues to dissipate in CY 11,885, in contrast to the IDF-East technetium-99 distribution, which continues to spread toward the Columbia River, with peak concentrations that approach or exceed benchmark concentrations in an area east of the Core Zone Boundary. Most of the technetium-99 distribution is at least one order of magnitude below its benchmark concentration between IDF-East and the Columbia River nearshore.



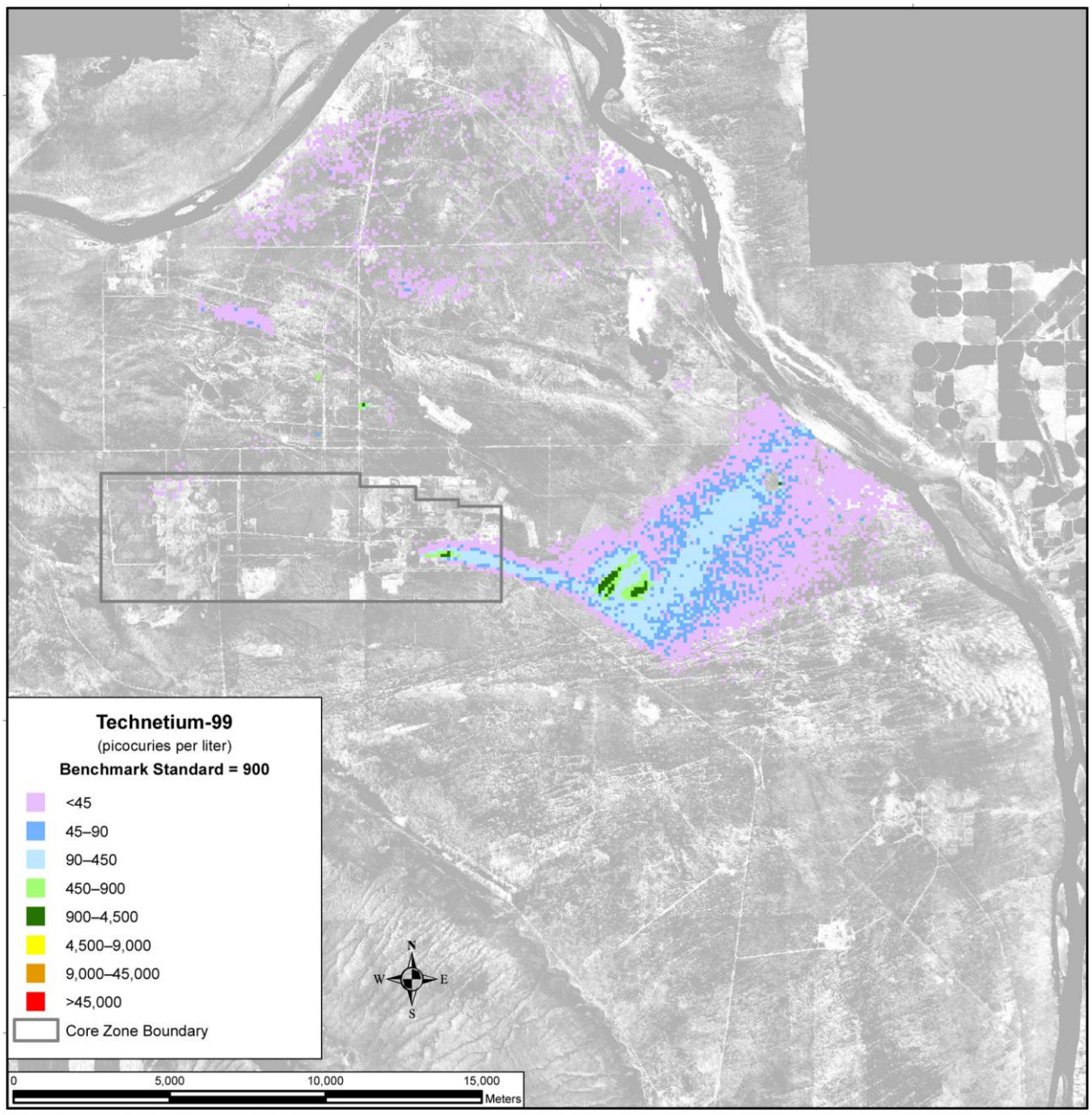
Note: To convert meters to feet, multiply by 3.281.

Figure 5–905. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

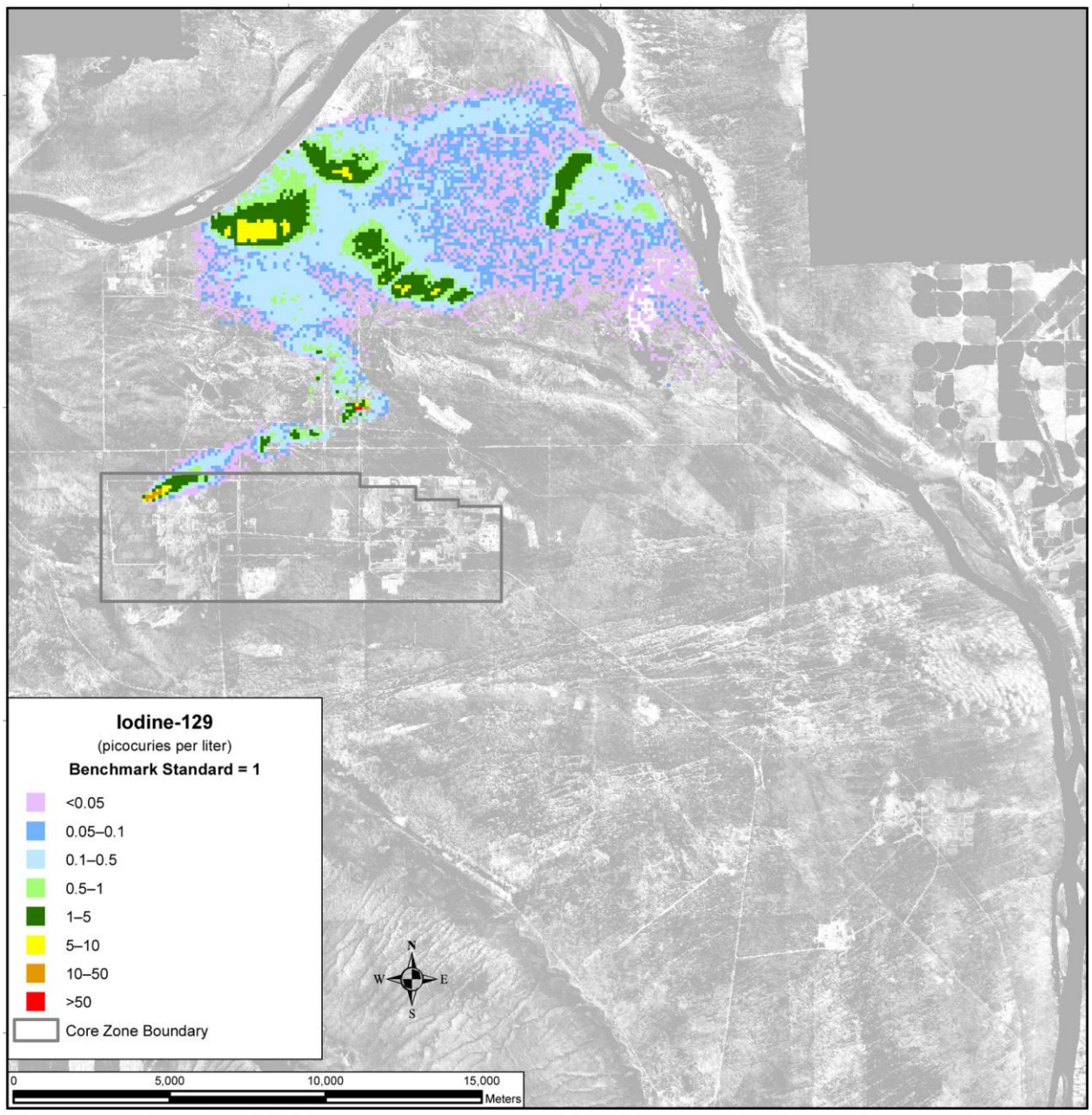
Figure 5–906. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



Note: To convert meters to feet, multiply by 3.281.

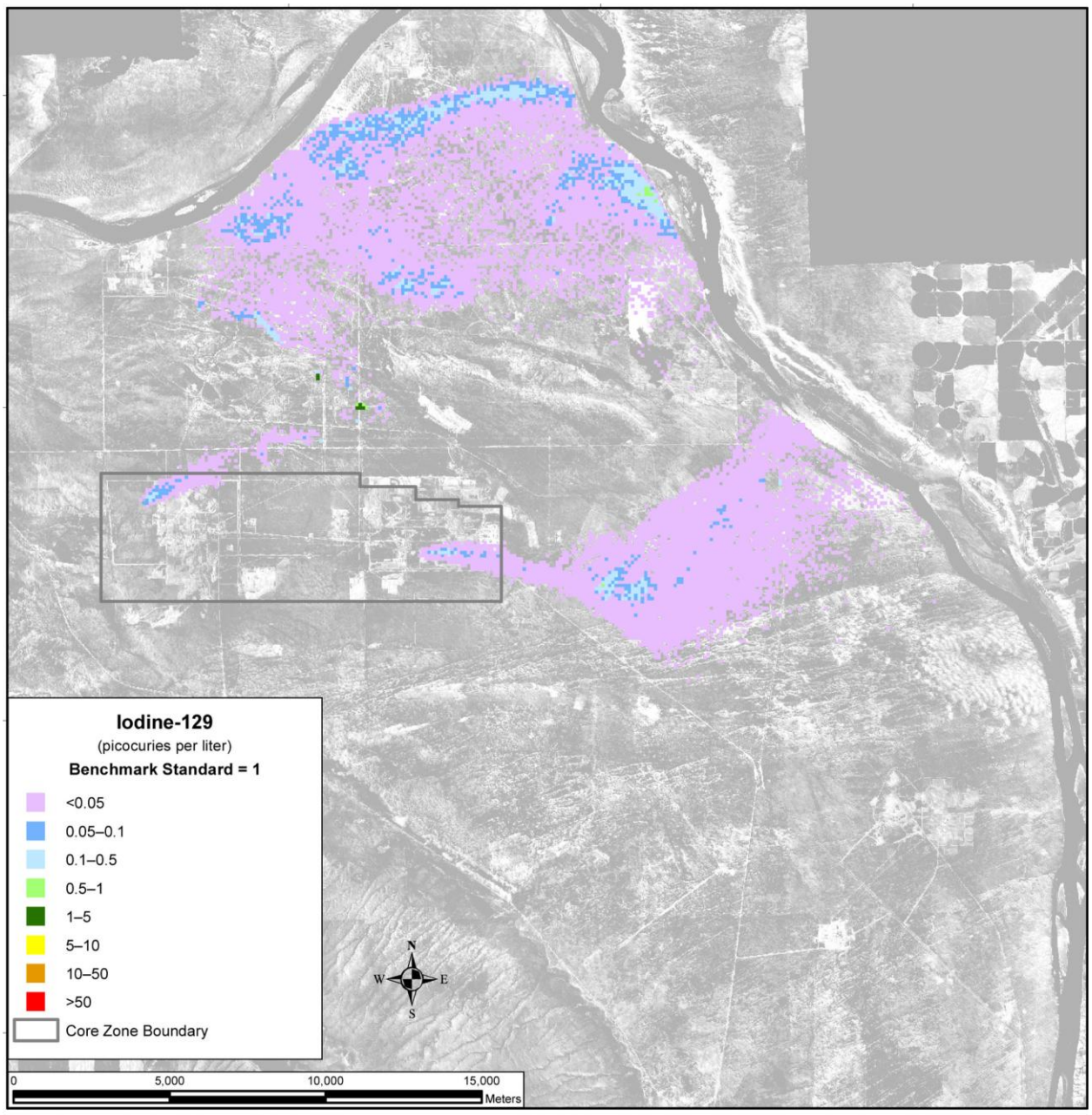
Figure 5–907. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885

Figures 5–908 through 5–910 show iodine-129 released from IDF-East and IDF-West with a spatial distribution very similar to the technetium-99 release. However, the CY 3890 iodine-129 release (see Figure 5–908) shows higher relative concentrations (compared with the benchmark concentration) than the technetium-99 release. The areas of high concentrations are in the same locales, but these areas have levels that exceed the benchmark concentration by at least one order of magnitude. No iodine-129 is released from IDF-East at this time. By CY 7140, the IDF-West iodine-129 release has significantly dissipated (see Figure 5–909); only small areas remain where iodine-129 is at or above its benchmark concentration. This shows the onset of the IDF-East iodine-129 release. By CY 11,885 (see Figure 5–910), the IDF-East iodine-129 distribution has significantly increased in size and concentration. Several small areas east of the Core Zone Boundary show concentrations at or above benchmark levels.



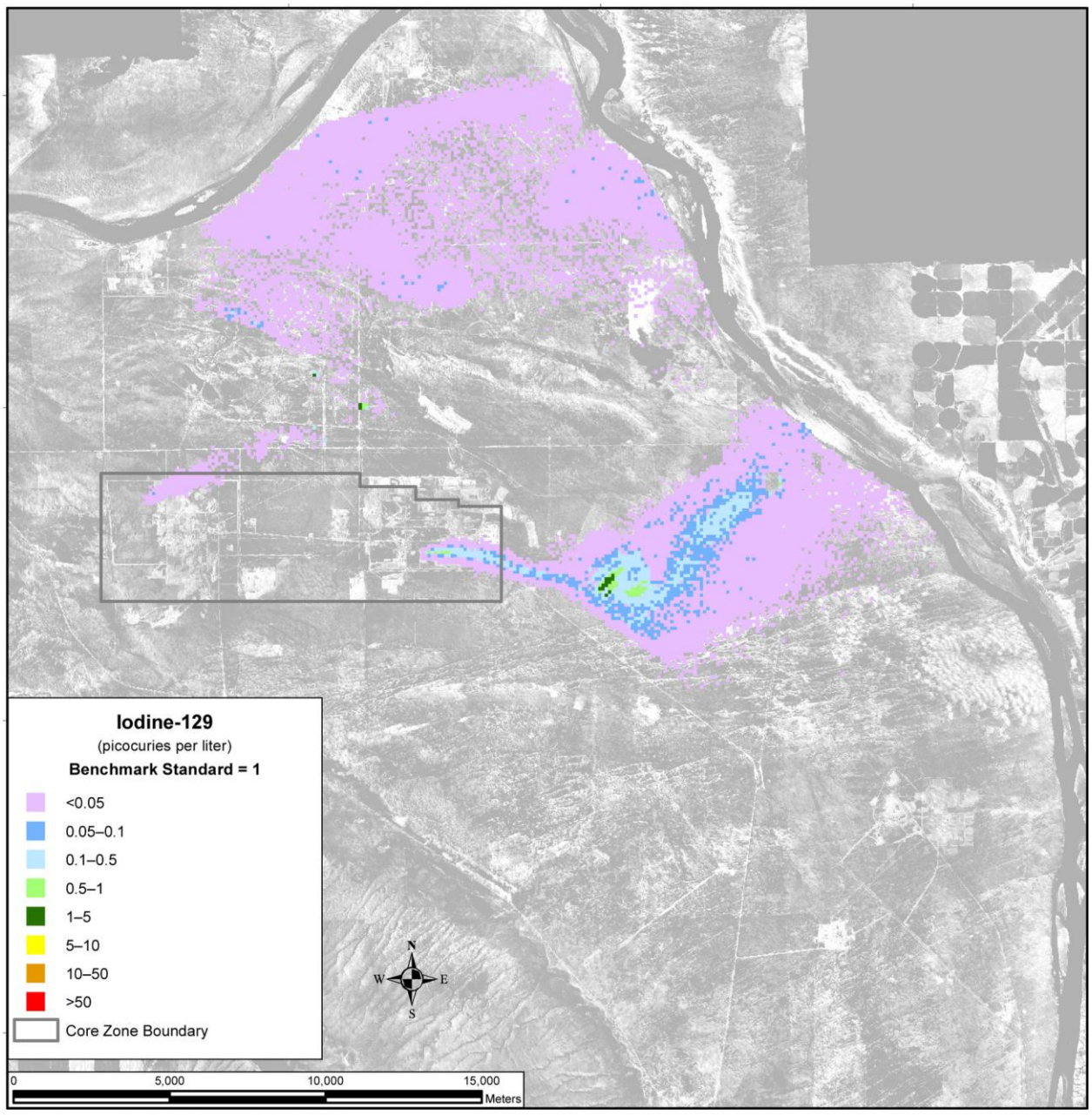
Note: To convert meters to feet, multiply by 3.281.

Figure 5–908. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

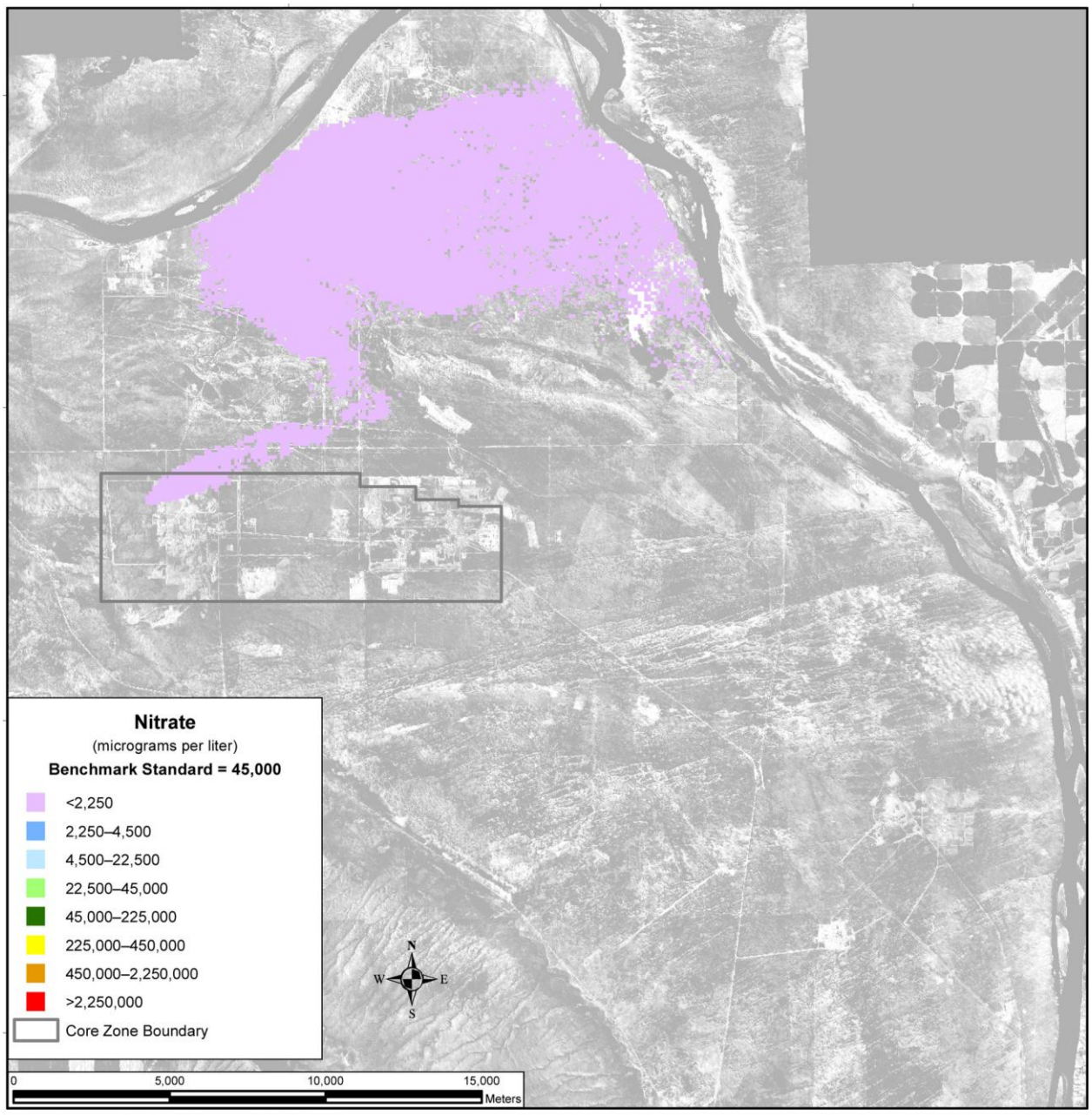
Figure 5–909. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



Note: To convert meters to feet, multiply by 3.281.

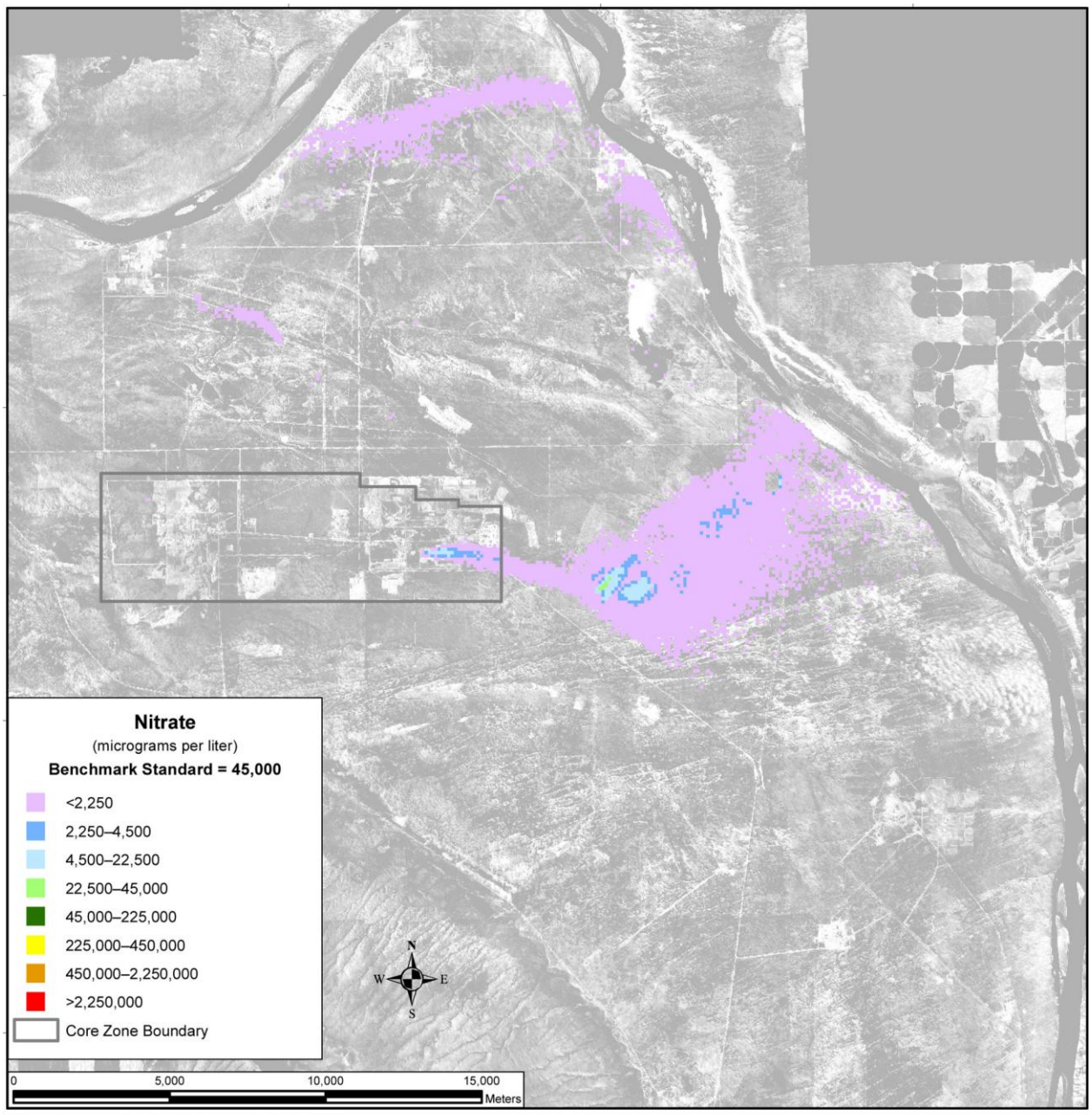
Figure 5–910. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885

The IDF-East and IDF-West nitrate releases, shown in Figures 5–911 through 5–913, show time and spatial distributions similar to the technetium-99 and iodine-129 releases. However, the IDF-East nitrate release never approaches benchmark concentrations and dissipates significantly by CY 7140 (almost nothing is showing in CY 11,885). The IDF-East nitrate release occurs later and does not appear in the CY 3890 data (see Figure 5–911). By CY 7140 (see Figure 5–912), the IDF-East nitrate release has reached the Columbia River. By CY 11,885 (see Figure 5–913), the nitrate has dissipated significantly and concentrations have fallen well below the benchmark concentration.



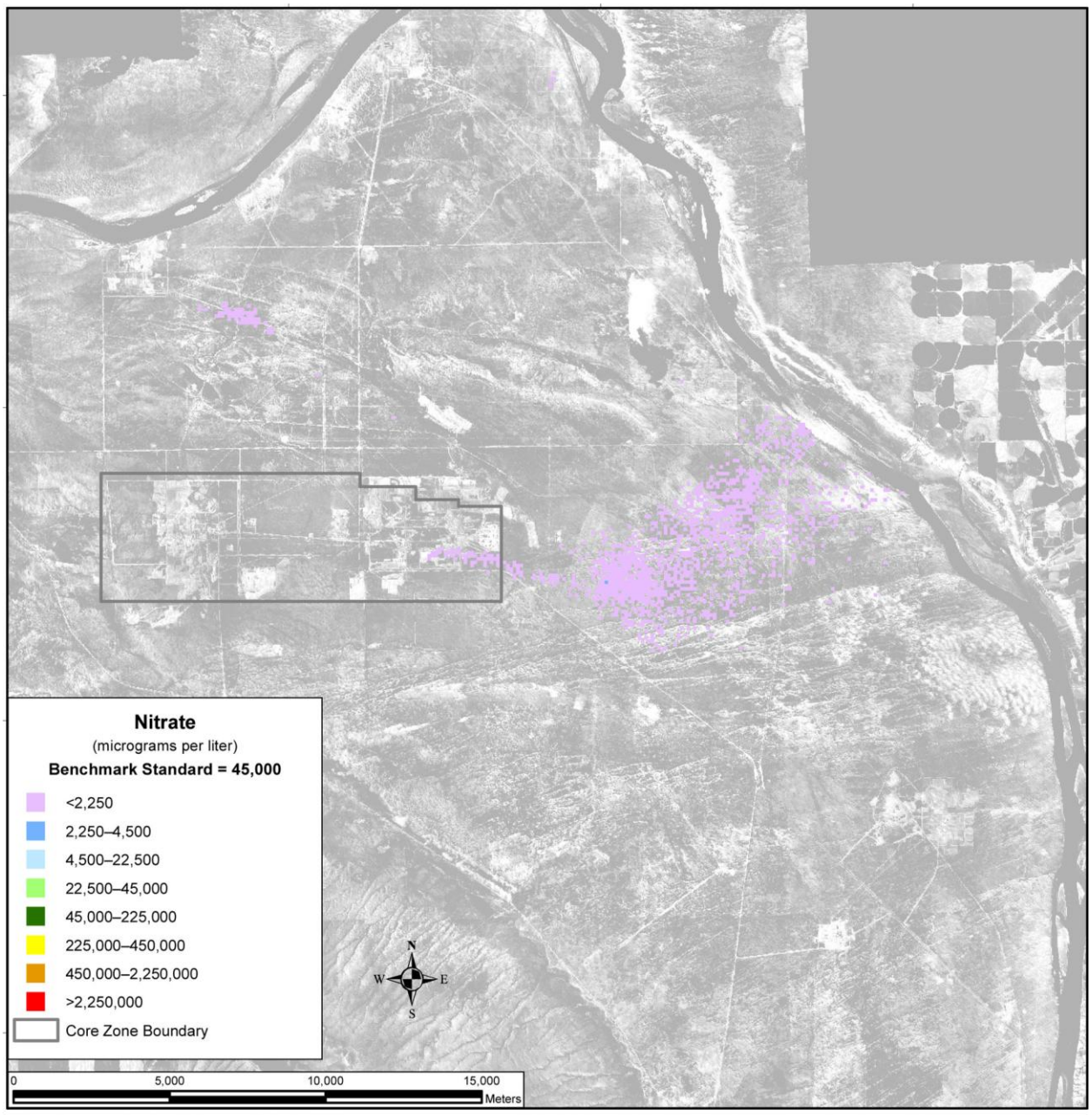
Note: To convert meters to feet, multiply by 3.281.

Figure 5–911. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

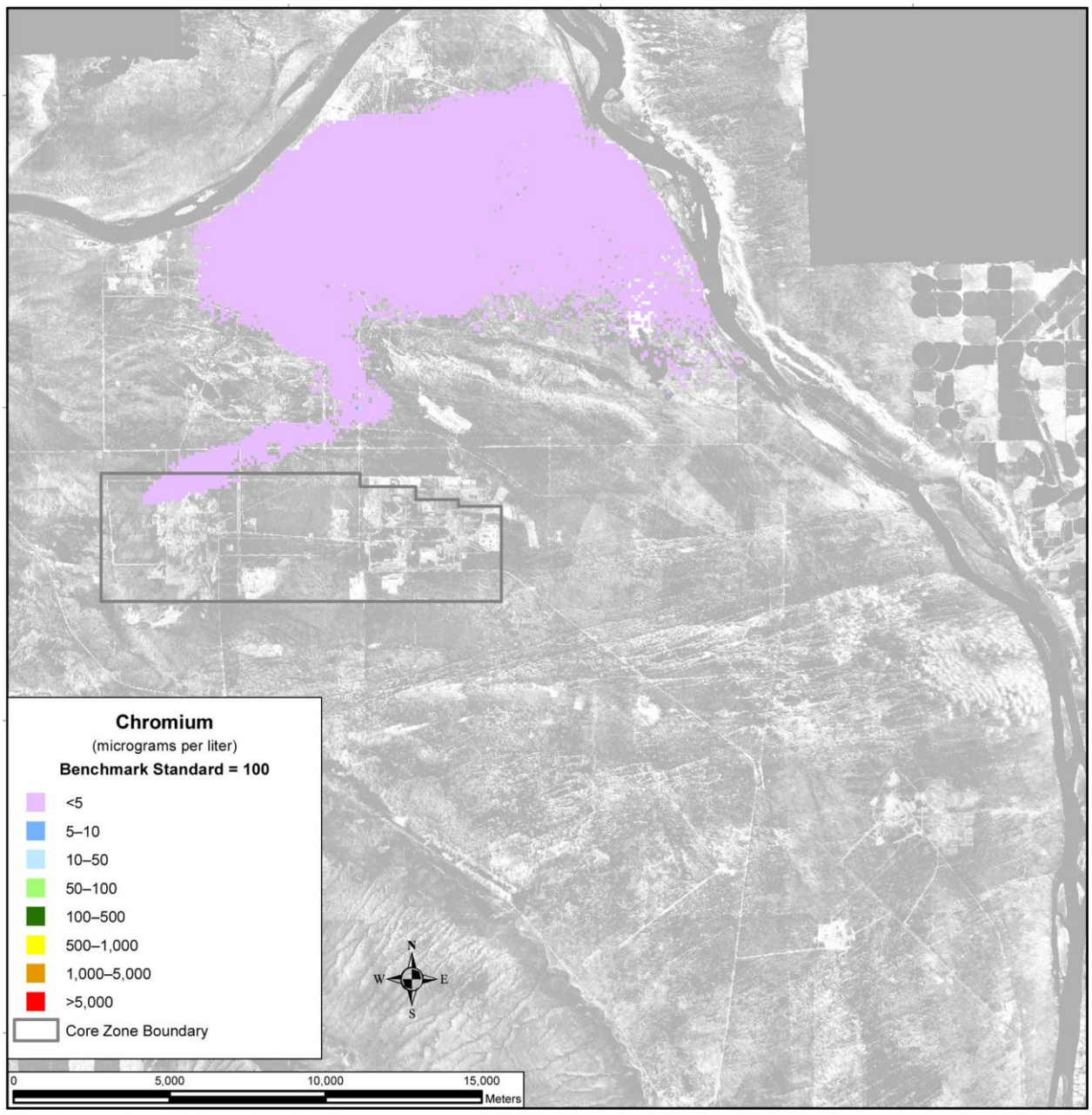
Figure 5–912. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



Note: To convert meters to feet, multiply by 3.281.

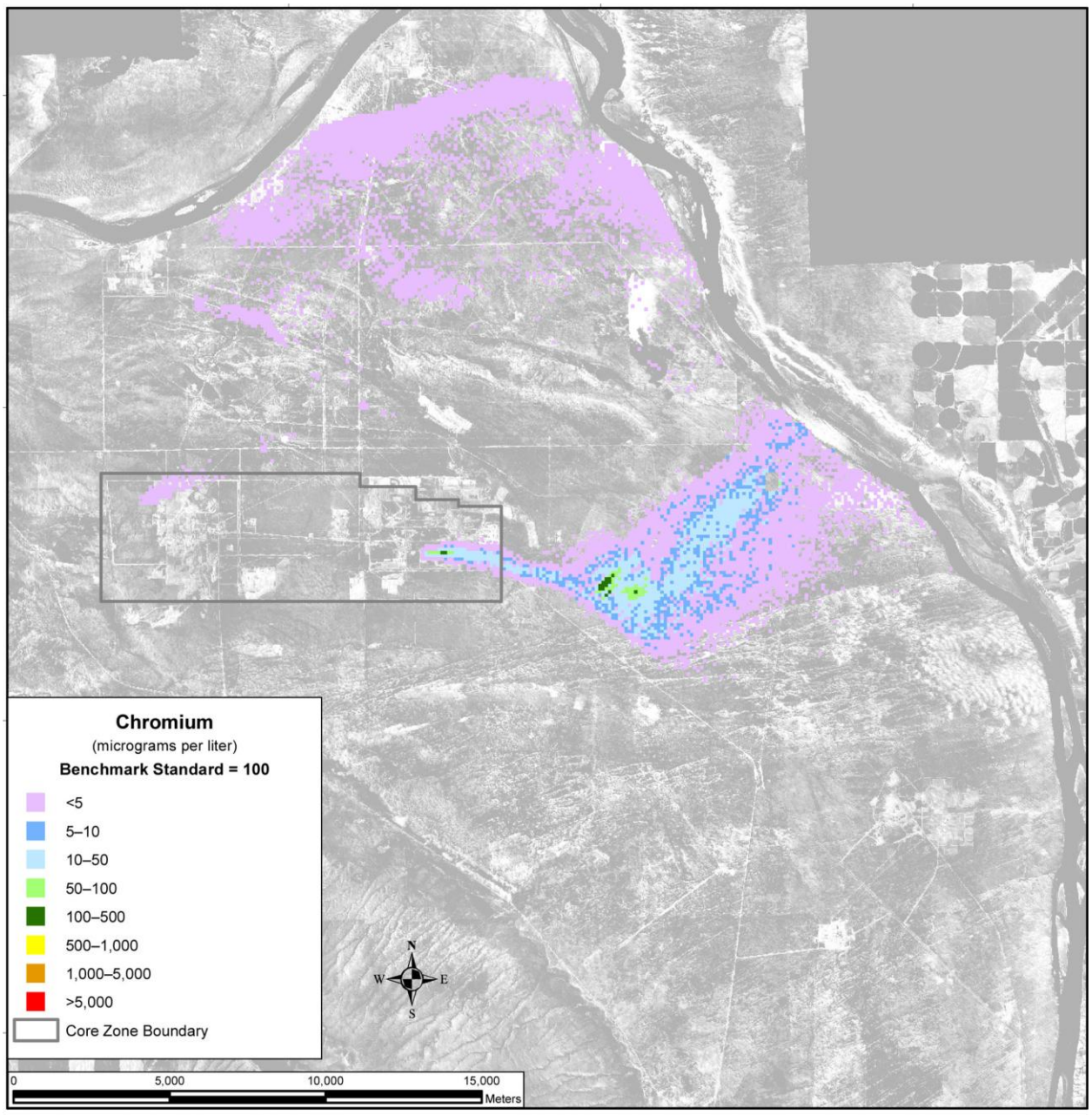
Figure 5–913. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

The initial chromium release time and spatial patterns in CY 3890 (see Figure 5–914) are nearly identical to the IDF-West nitrate release. The chromium concentrations in CY 3890 are several orders of magnitude below the benchmark level. By CY 7140, most of this low-concentration IDF-West chromium has dissipated to the Columbia River (see Figure 5–915). By CY 7140, there is a significant chromium distribution from IDF-East, with small areas that exceed benchmark concentrations. By CY 11,885 (see Figure 5–916), the IDF-West chromium has essentially dissipated. The IDF-East chromium release extends from the release site to the Columbia River, but with concentrations that are well below the chromium benchmark concentration.



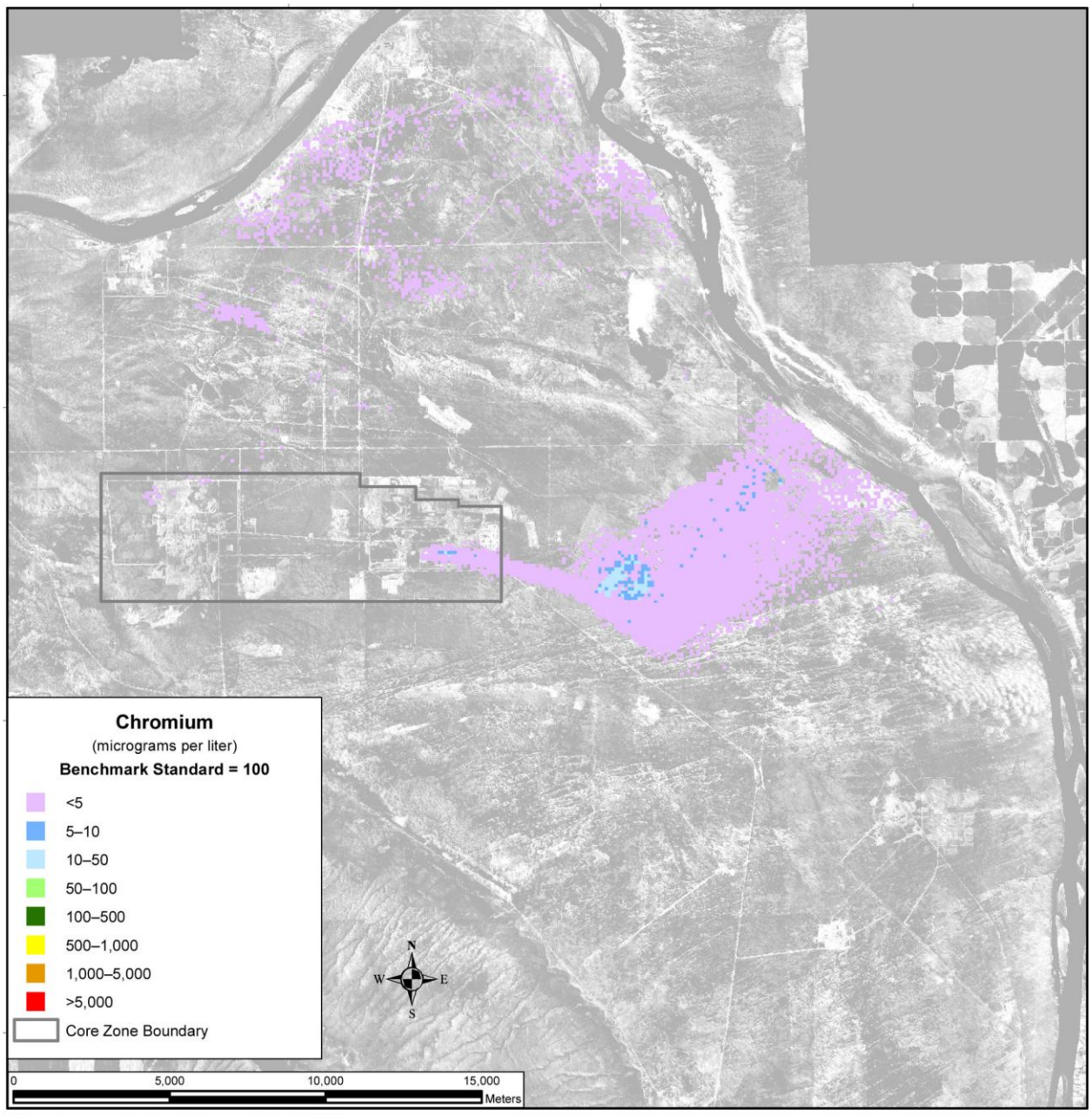
Note: To convert meters to feet, multiply by 3.281.

Figure 5–914. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

Figure 5–915. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



Note: To convert meters to feet, multiply by 3.281.

Figure 5–916. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-F, in general, the inventories remaining in IDF-East and IDF-West, which are available for release to the environment at the start of the post-disposal period, are predominant contributors. The releases from IDF-West occur earlier and dissipate earlier than releases from IDF-East.

By the end of this analysis period (CY 11,885), the chromium and nitrate distributions have largely dispersed below their benchmark concentrations. Significant spatial distributions of technetium-99 and iodine-129 remain. Most of the distribution area has concentrations below benchmark levels, but there are some small areas in which technetium-99 and iodine-129 concentrations exceed benchmark levels in

CY 11,885. The released iodine-129, which occurs at higher concentration levels relative to its benchmark than technetium-99, dissipates much more quickly than technetium-99.

For uranium-238 and total uranium, limited mobility is an important factor governing the timeframe and scale of groundwater impacts. The concentrations of those retarded species do not exceed the benchmark levels at the Core Zone Boundary or Columbia River nearshore over the period of analysis.

5.3.1.3.1.7 Disposal Group 1, Subgroup 1-G

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, was designed to accommodate the disposal of wastes generated under Tank Closure Alternative 6C and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste. Tank closure waste would be converted to IHLW and ILAW glass. The ILAW glass would be stored on site as HLW pending disposition.

For the long-term groundwater impacts analysis, two major periods have been identified for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, as follows:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East and IDF-West in CY 2009 and in the RPPDF in CY 2022 and continue through CY 2050, when these disposal facilities would be operationally closed. During the disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2051 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in IDF-East, IDF-West, and the RPPDF would become available for release to the environment, and it was assumed for analysis purposes that barriers would be emplaced over the facilities to limit infiltration during the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G. Complete results for all 40 COPCs are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, is focused on the following COPC drivers:

- Radiological risk drivers: iodine-129, technetium-99, and uranium-238
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, nitrate, and total uranium

The COPC drivers for Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. Uranium-238 and total uranium were added to the COPC drivers; although their contribution to risk and hazard are not dominant during the year of peak risk or hazard, they become major contributors toward the end of the period of analysis. The radiological risk drivers listed above account for essentially 100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard drivers above account for 100 percent of the chemical hazard associated with Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G.

The COPC drivers that are discussed in detail in this section fall into two categories. Iodine-129, technetium-99, chromium, and nitrate are all mobile (i.e., they move with groundwater) and long-lived

(relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. Uranium-238 and total uranium are long-lived, or stable, but are not as mobile as the other COPC drivers. These constituents move about seven times more slowly than groundwater. As the analyses of release, concentration versus time, and spatial distribution of the COPC drivers are presented, the distinct behavior of these groups will become apparent.

The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, in terms of the total amount of COPCs released from IDF-East, IDF-West, and the RPPDF to the vadose zone, groundwater, and the Columbia River during the 10,000-year period of analysis. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over six orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

Figure 5–917 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–918, the chemical hazard drivers. Two subtotals are plotted in Figures 5–917 through 5–922, representing releases from IDF-East, which include ETF-generated secondary waste and tank closure secondary waste. For technetium-99, chromium, and nitrate in grouted waste forms, the release to the vadose zone is controlled by the inventory (i.e., nearly all of the inventory is released during the period of analysis). The predominant source of technetium-99 and chromium is tank closure secondary waste. ETF-generated secondary waste is the predominant source of iodine-129 and nitrate.

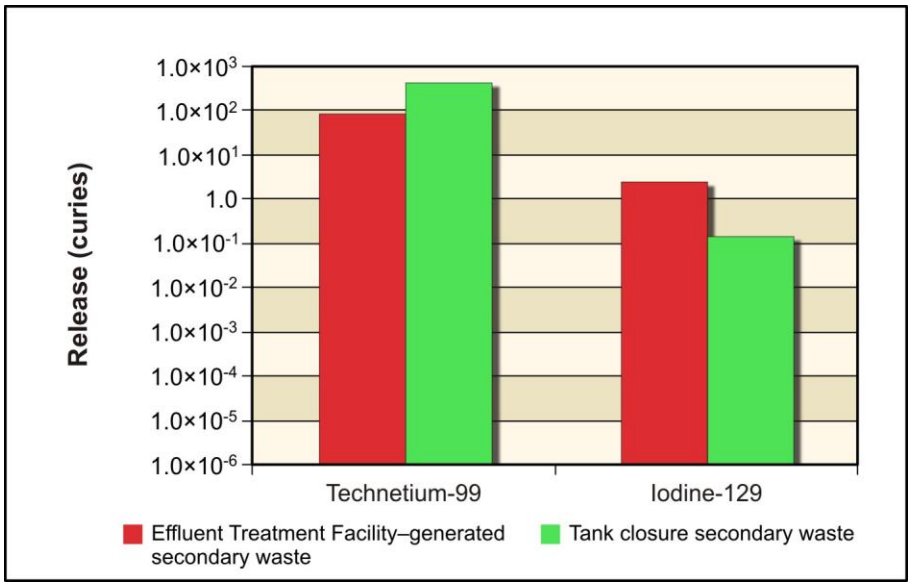


Figure 5–917. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

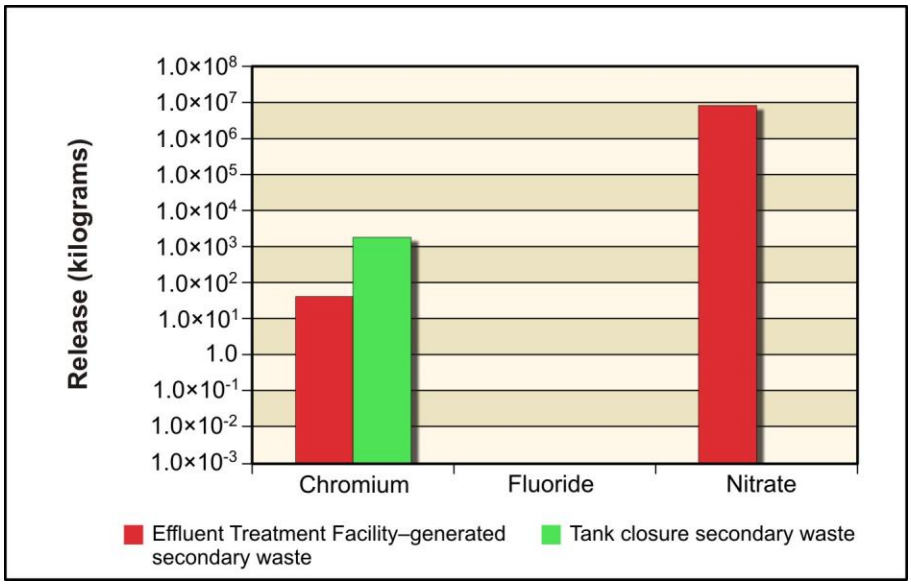


Figure 5–918. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–919 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–920, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. Nearly all of the technetium-99 released from ETF-generated secondary waste to the vadose zone reaches groundwater during the period of analysis, but only approximately 40 to 50 percent of the technetium-99 from other sources and iodine-129 released to the vadose zone reaches groundwater. Nearly all chromium and nitrate released to the vadose zone reaches groundwater.

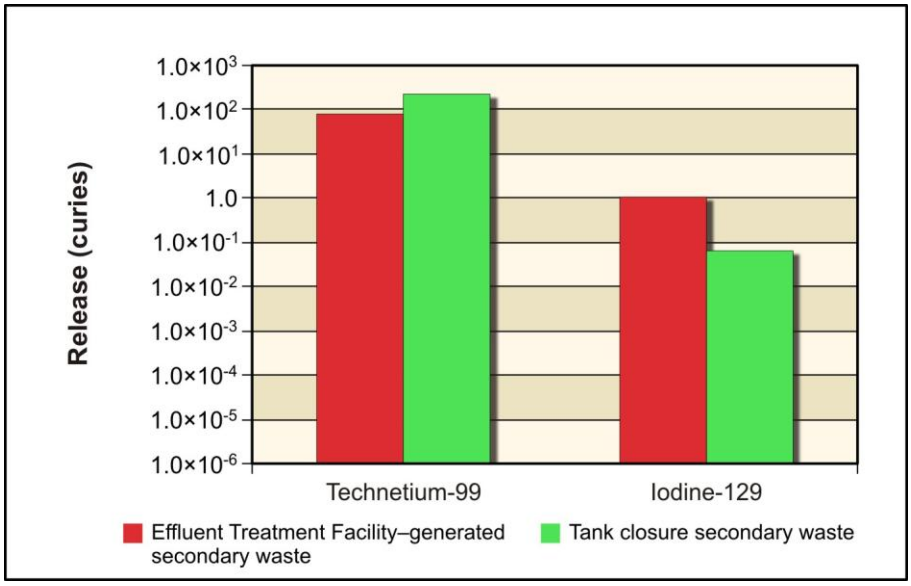


Figure 5–919. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

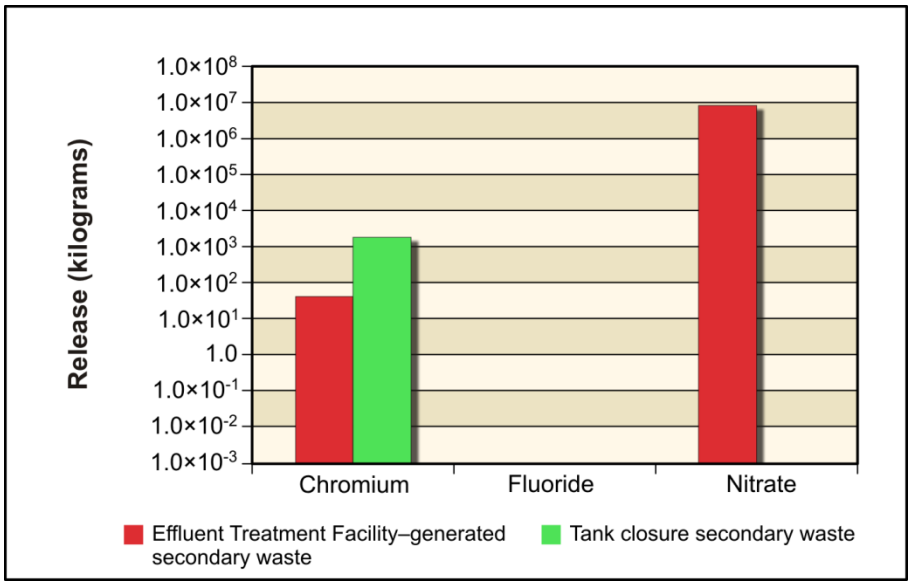


Figure 5–920. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–921 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–922, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. In all cases, between 96 and 100 percent of the amount released to groundwater reaches the Columbia River.

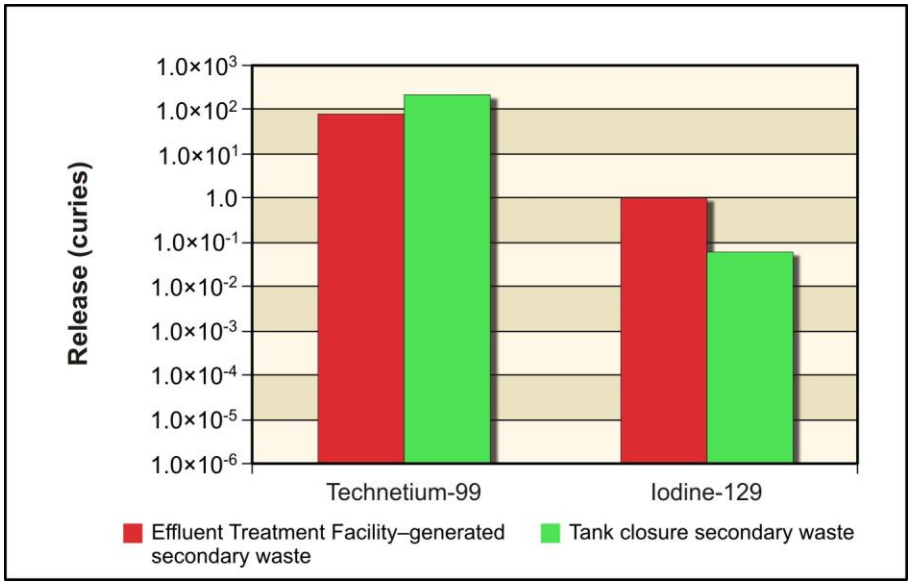


Figure 5–921. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

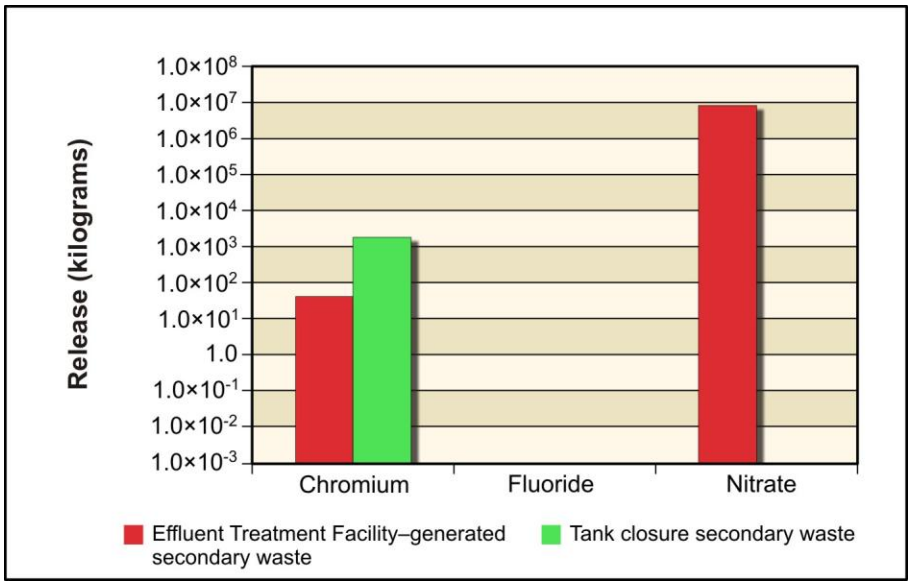


Figure 5–922. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

200-West Area Integrated Disposal Facility

Three subtotals are plotted in Figures 5–923 through 5–928, representing releases from IDF-West, which include FFTF Decommissioning Alternative 3 waste, waste management secondary waste and onsite waste, and offsite waste. Figure 5–923 shows the estimated release from IDF-West to the vadose zone of the radiological risk drivers and Figure 5–924, the chemical hazard drivers. For offsite waste, the release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the period of analysis). Technetium-99, iodine-129, chromium, fluoride, and nitrate are all present at IDF-West.

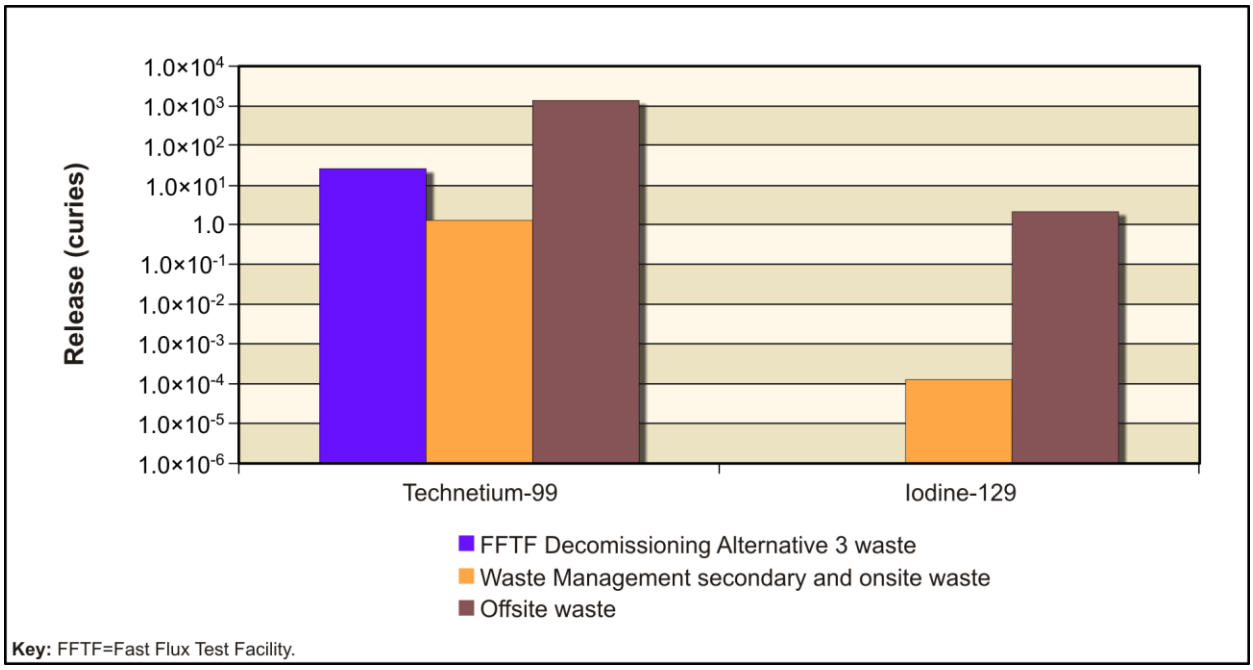


Figure 5–923. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

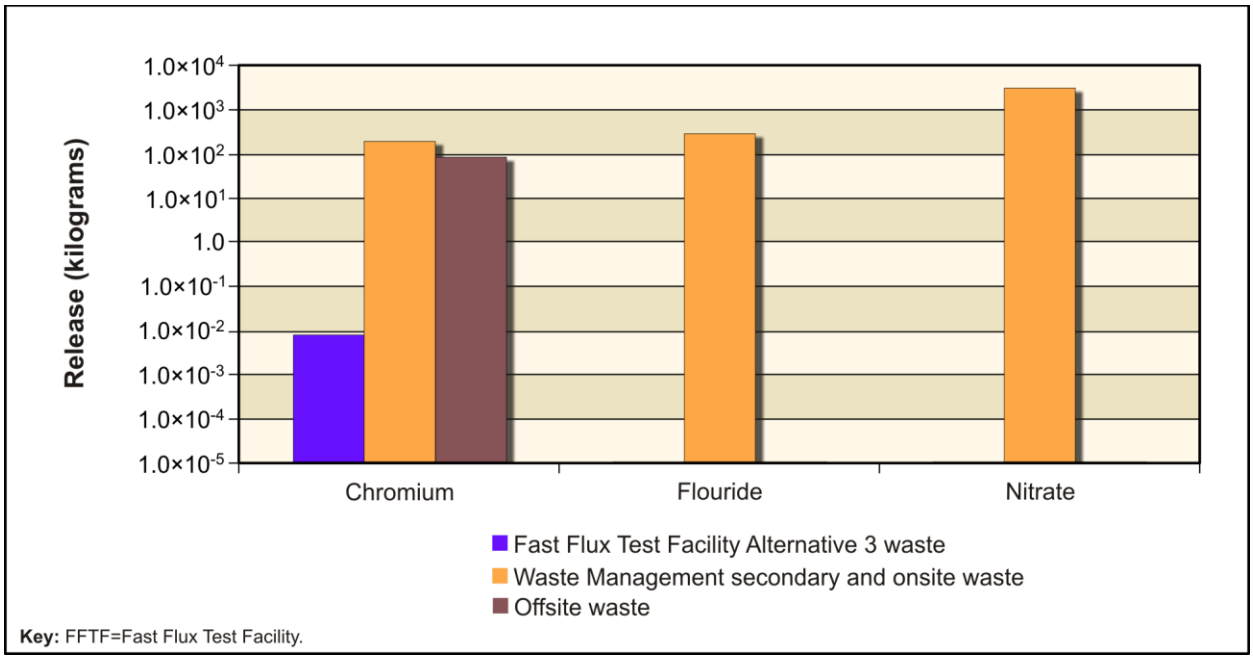


Figure 5–924. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chemical Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

Figure 5–925 shows the estimated release from IDF-West to groundwater of the radiological risk drivers and Figure 5–926, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. All of the COPC drivers present at IDF-West behave as conservative tracers, with essentially all of the mass released to the vadose zone reaching groundwater.

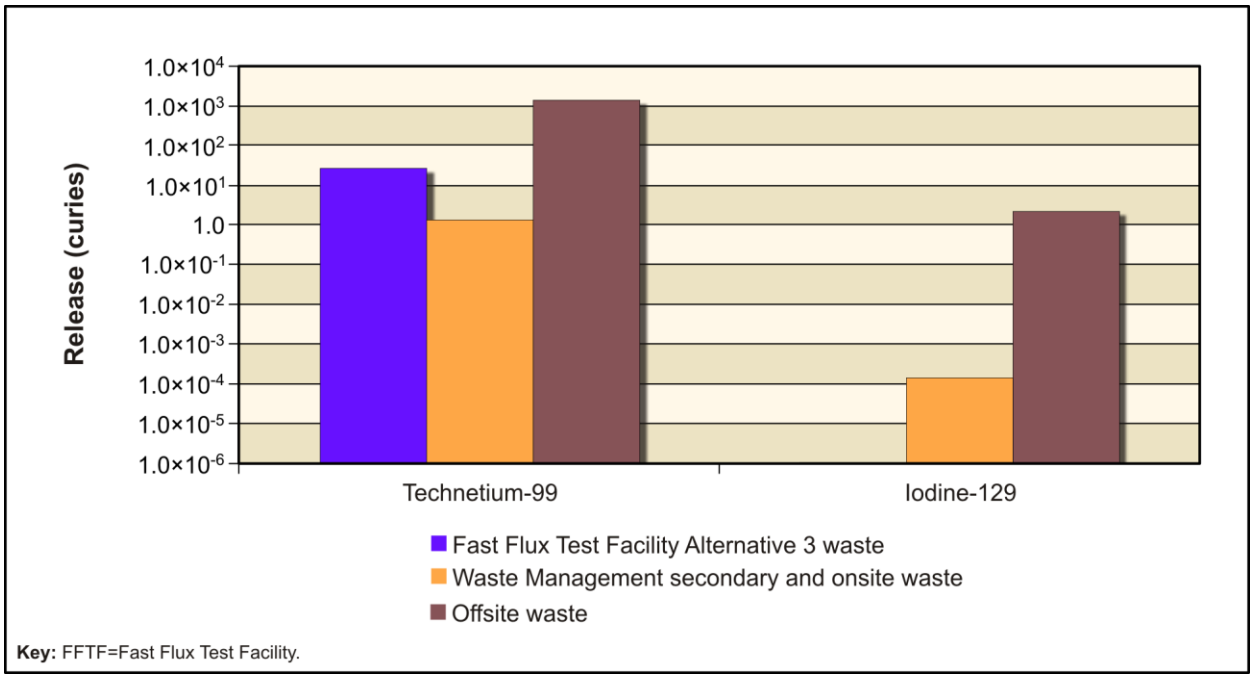


Figure 5–925. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Groundwater

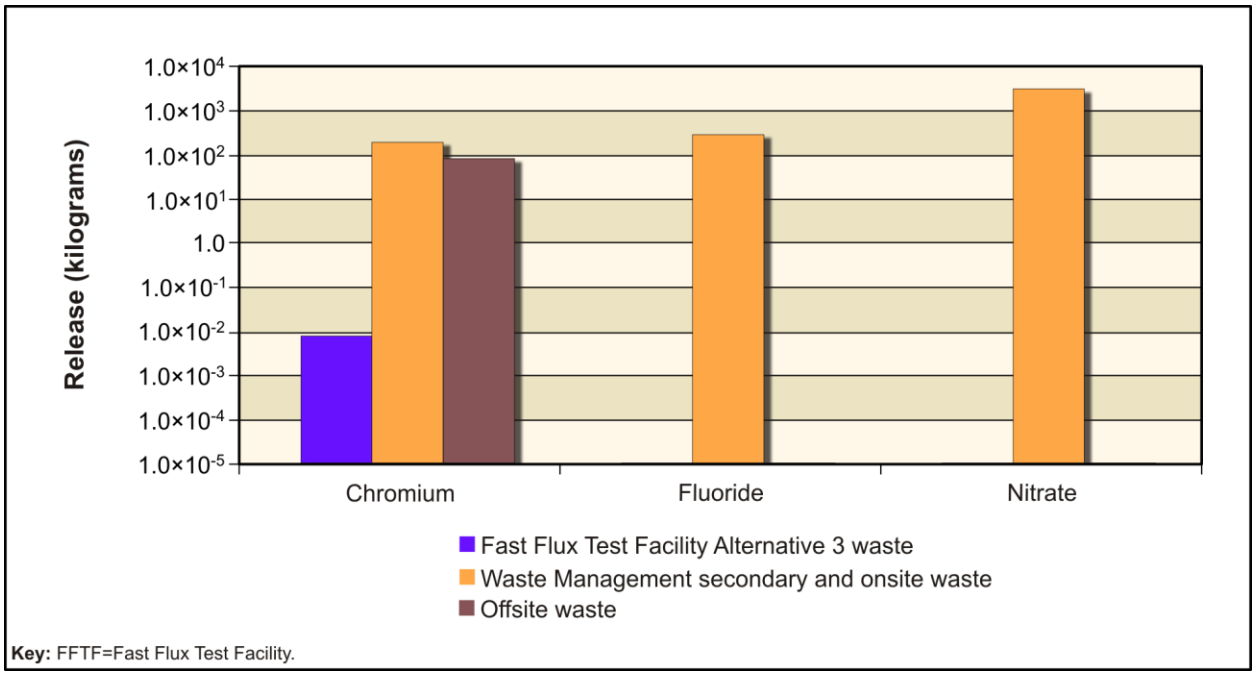


Figure 5–926. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chemical Releases from 200-West Area Integrated Disposal Facility to Groundwater

Figure 5–927 shows the estimated release from IDF-West to the Columbia River of the radiological risk drivers and Figure 5–928, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Essentially everything released to groundwater reaches the Columbia River for all COPC drivers present during the period of analysis.

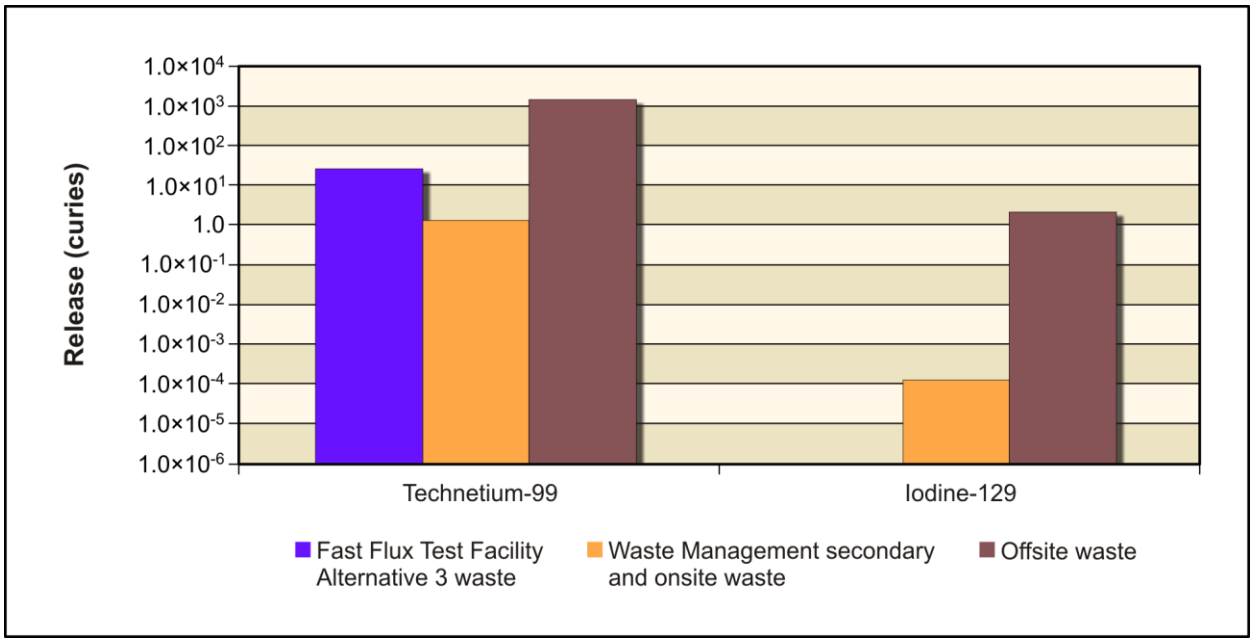


Figure 5–927. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Columbia River

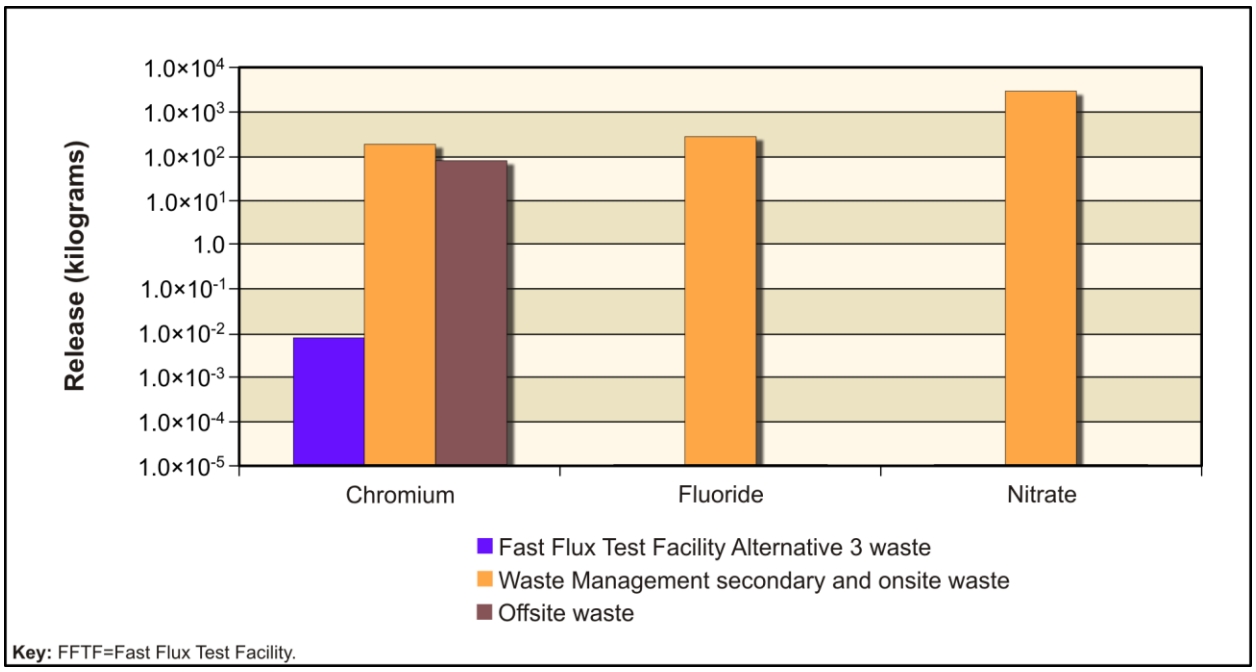


Figure 5–928. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chemical Releases from 200-West Area Integrated Disposal Facility to Columbia River

River Protection Project Disposal Facility

The RPPDF would receive lightly contaminated equipment and soils resulting from tank farm closure activities. Figure 5–929 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–930, the chemical hazard drivers. For all types of sources, the release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the period of analysis). Technetium-99, iodine-129, chromium, and nitrate are all present at the RPPDF.

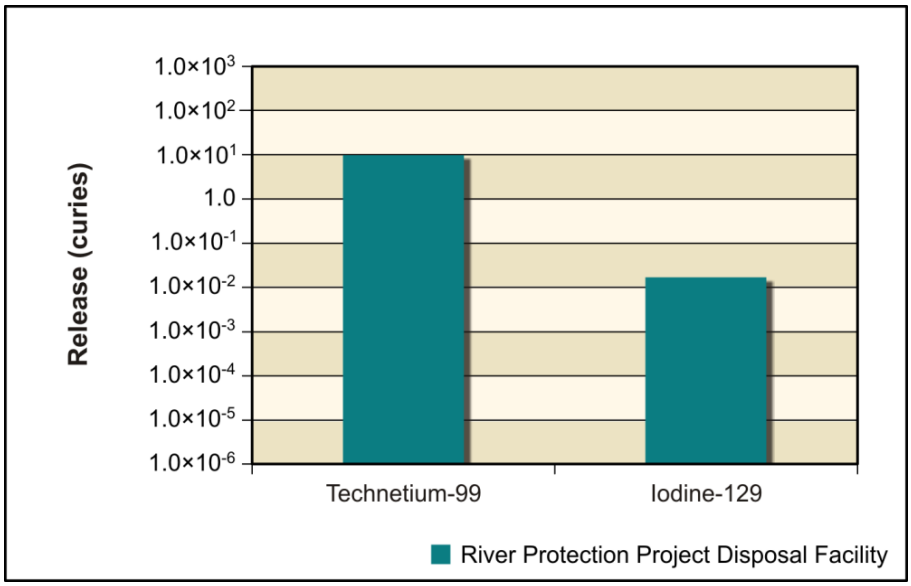


Figure 5–929. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

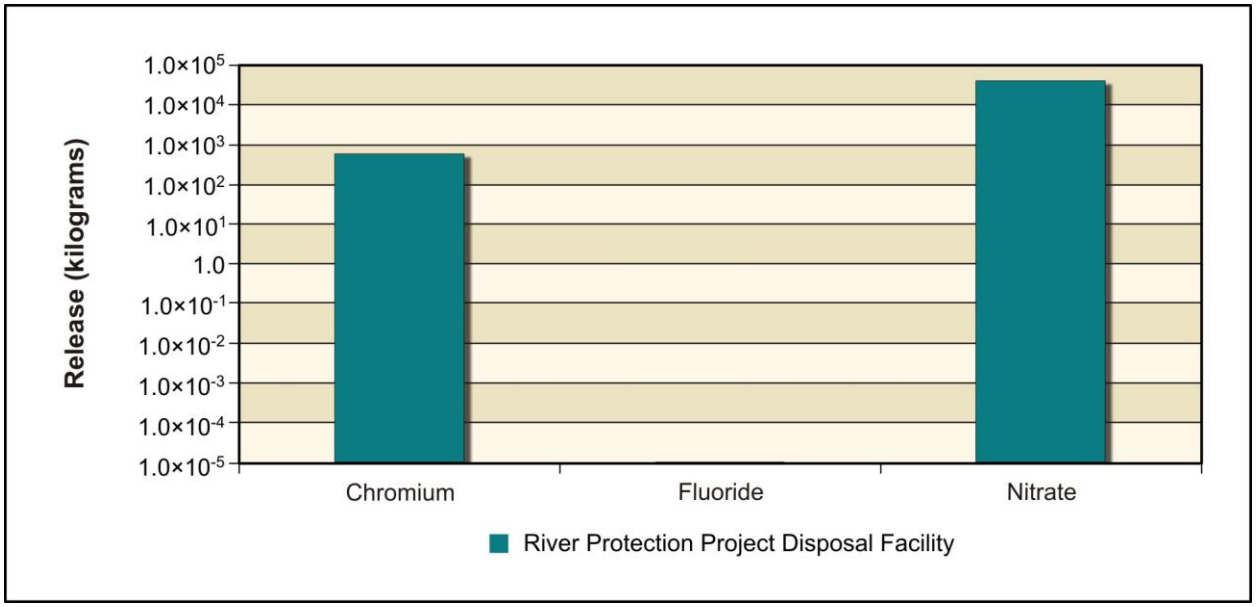


Figure 5–930. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–931 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–932, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. All of the COPC drivers present at the RPPDF behave as conservative tracers, with essentially all of the mass released to the vadose zone reaching groundwater.

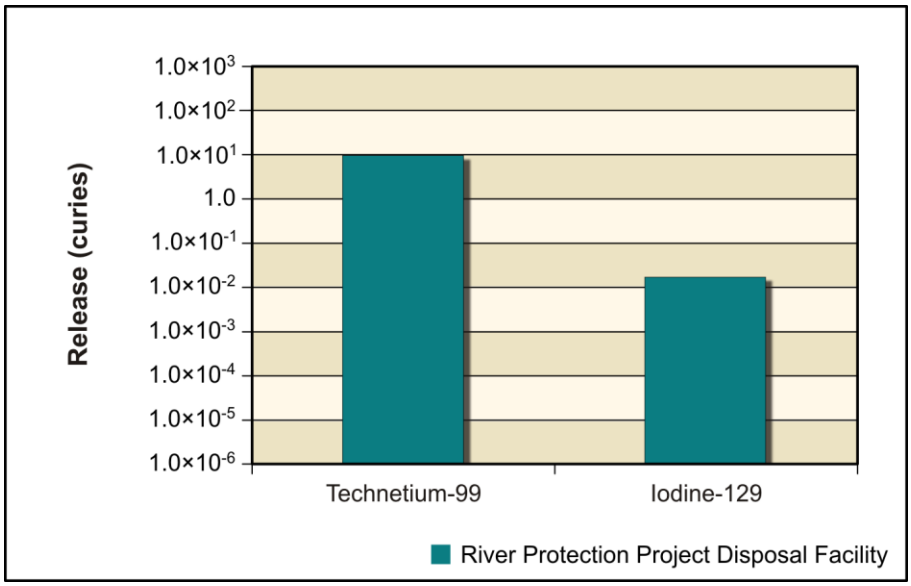


Figure 5–931. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

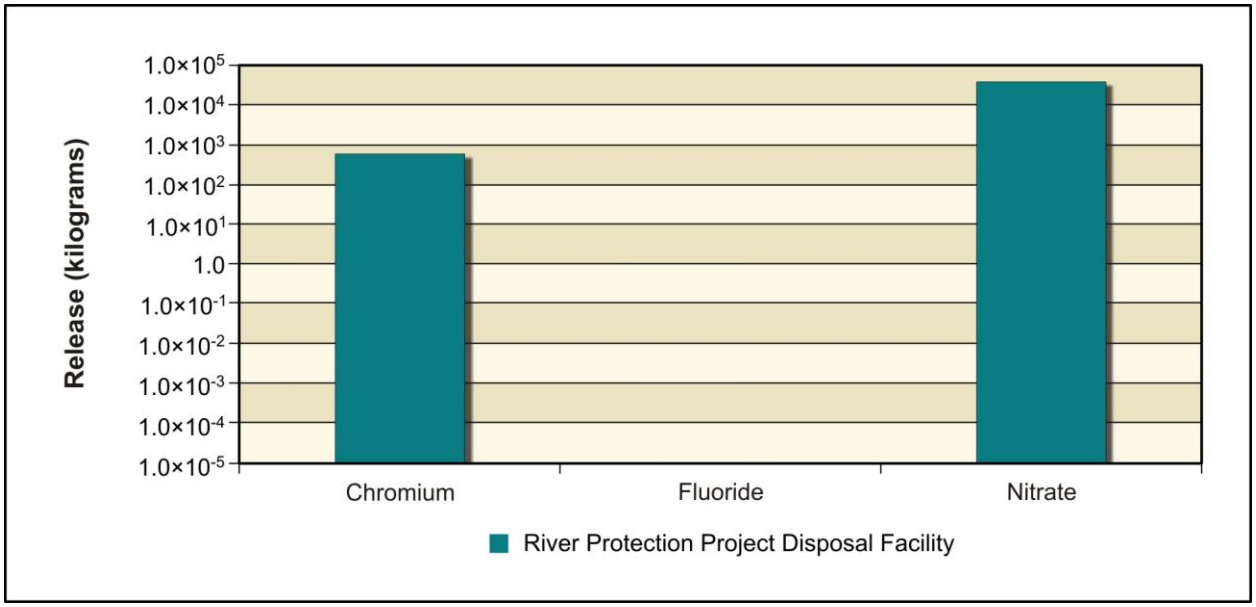


Figure 5–932. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–933 shows the estimated release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–934, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. Essentially everything released to groundwater reaches the Columbia River for all COPC drivers present.

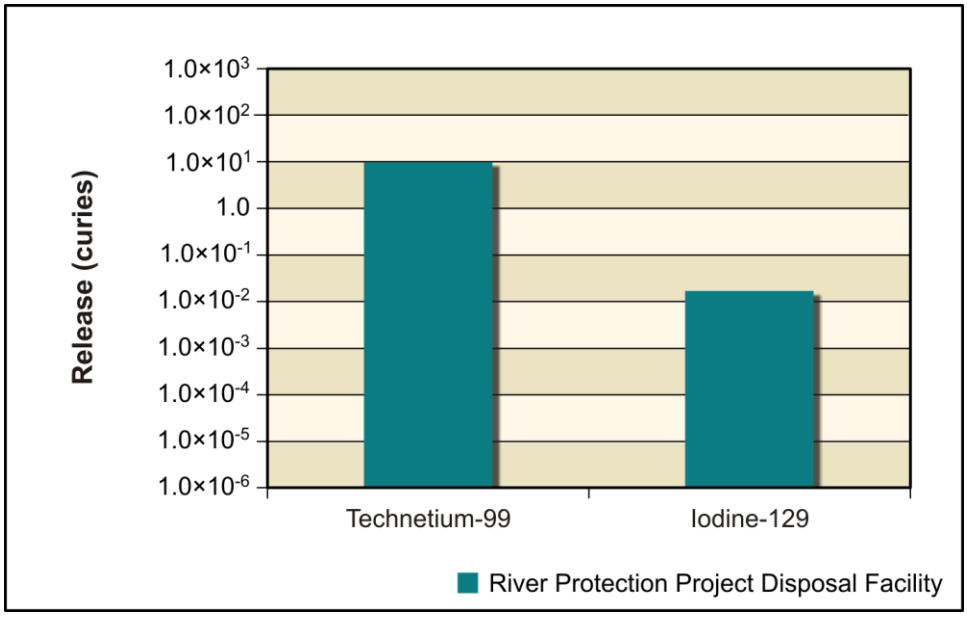


Figure 5–933. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

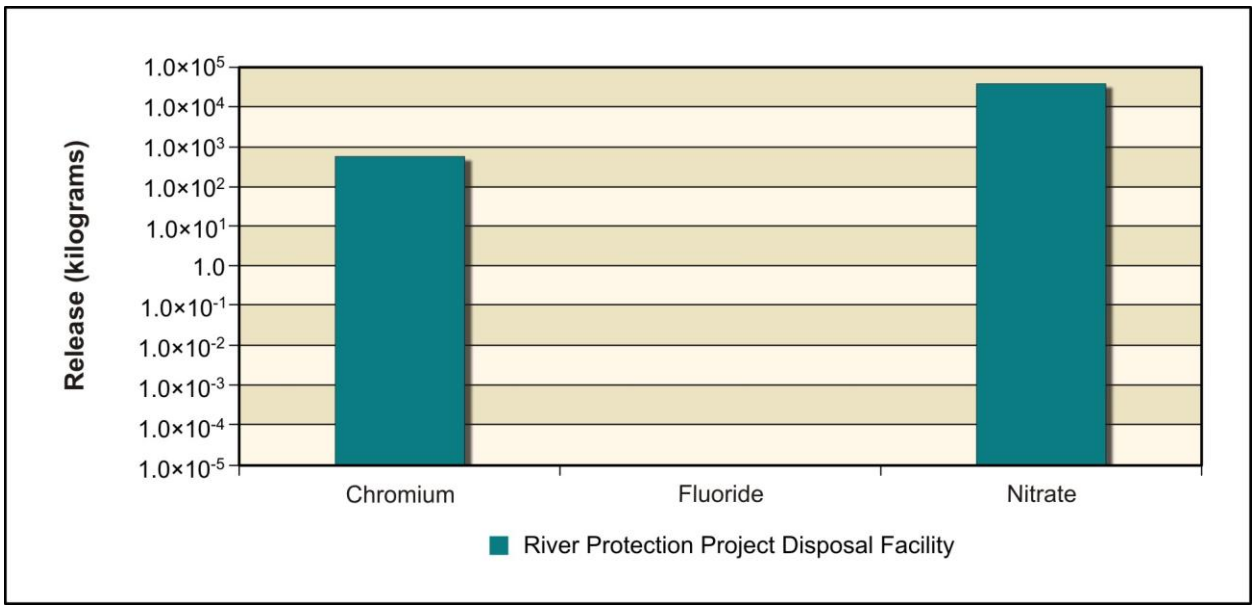


Figure 5–934. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, in terms of groundwater concentration versus time at the Core Zone Boundary and the Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. The benchmark concentration of each radionuclide and chemical is also shown. Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations that vary over three orders of magnitude. Table 5–112 shows the maximum concentrations in groundwater. The data indicate that exceedances of benchmark concentrations are present primarily at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore because of high concentrations of technetium-99 and iodine-129. Concentrations of iodine-129 at the IDF-East barrier also reach the benchmark value in CY 10,177. No other COPC driver concentrations exceed the respective benchmark values.

Table 5–112. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Maximum COPC Concentrations in the Peak Year at IDF-East, IDF-West, and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	IDF-West	RPPDF	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	208	**13,200**	42	**1,370**	**1,670**	900
	(11,385)	(3818)	(3818)	(3859)	(3920)	
Iodine-129	1.0	**20.6**	0.1	**2.1**	**2.4**	1
	(10,177)	(3794)	(3747)	(3937)	(3872)	
Chemical (micrograms per liter)						
Chromium	2	1	3	1	0	100
	(8555)	(3813)	(3740)	(3846)	(4481)	
Fluoride	0	1	0	0	0	4,000
	(1940)	(4014)	(3983)	(3937)	(4307)	
Nitrate	12,100	7	180	3,010	2,030	45,000
	(7962)	(3927)	(3670)	(8248)	(7535)	

Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Figures 5–935 through 5–938 show concentration versus time for technetium-99, iodine-129, chromium, and nitrate (the conservative tracers). For technetium-99, concentrations rise early in the simulation, reaching a peak around CY 3940, when concentrations at the IDF-West barrier are at about an order of magnitude above the benchmark concentration. Technetium-99 concentrations at the Core Zone Boundary and Columbia River nearshore are less than an order of magnitude above the benchmark. Concentrations drop until around CY 7940, when they begin to stabilize between one and two orders of magnitude below the benchmark. Technetium-99 concentrations at the IDF-East barrier begin to rise at around CY 4940 but level out at about one order of magnitude below the benchmark concentration. Iodine-129 follows a pattern similar to that of technetium-99, stabilizing an order of magnitude below the benchmark after peaking at between one and two orders of magnitude above the benchmark around CY 3940. Chromium concentrations at the Core Zone Boundary peak nearly two orders of magnitude below the benchmark before concentrations drop sharply. Around CY 5400, concentrations begin rising again, with a peak over two orders of magnitude below the benchmark. Nitrate has a similar two-peaked pattern, with the first peak remaining three orders of magnitude below the benchmark at the Core Zone Boundary, while the second peak is only one order of magnitude below the benchmark at the IDF-East barrier.

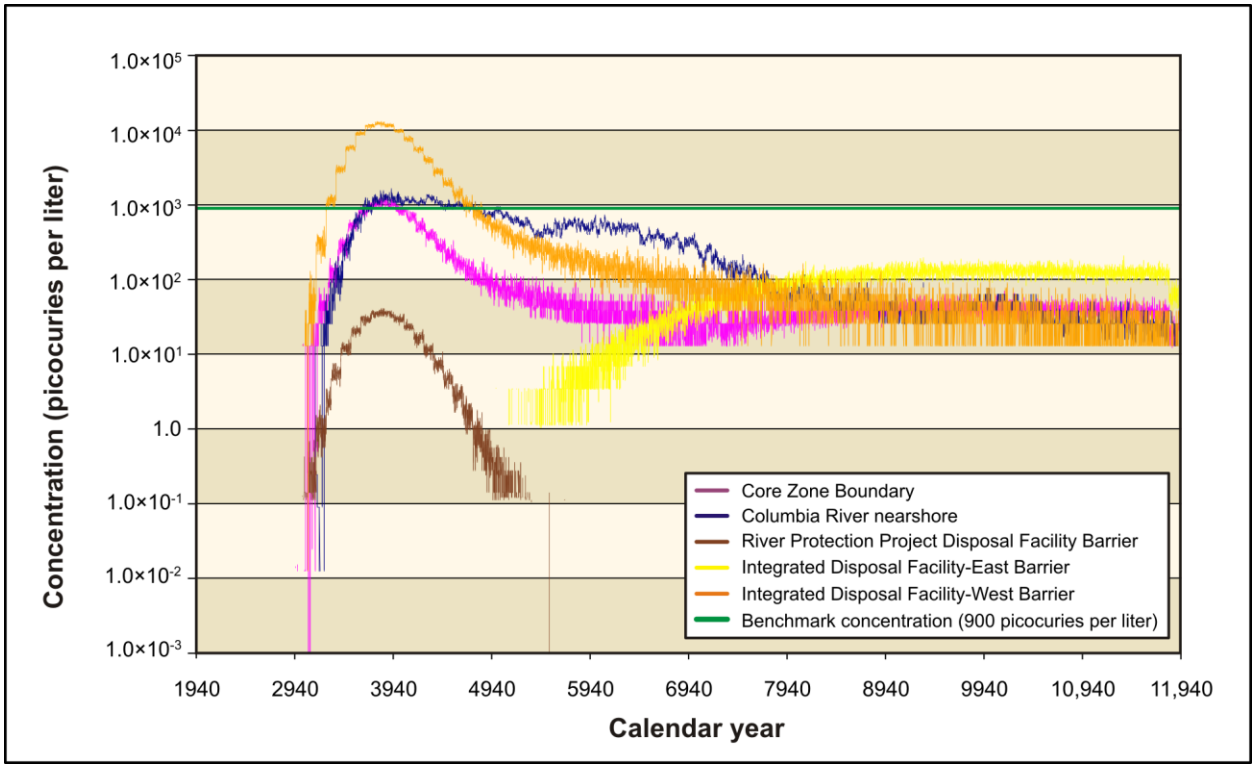


Figure 5–935. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Technetium-99 Concentration Versus Time

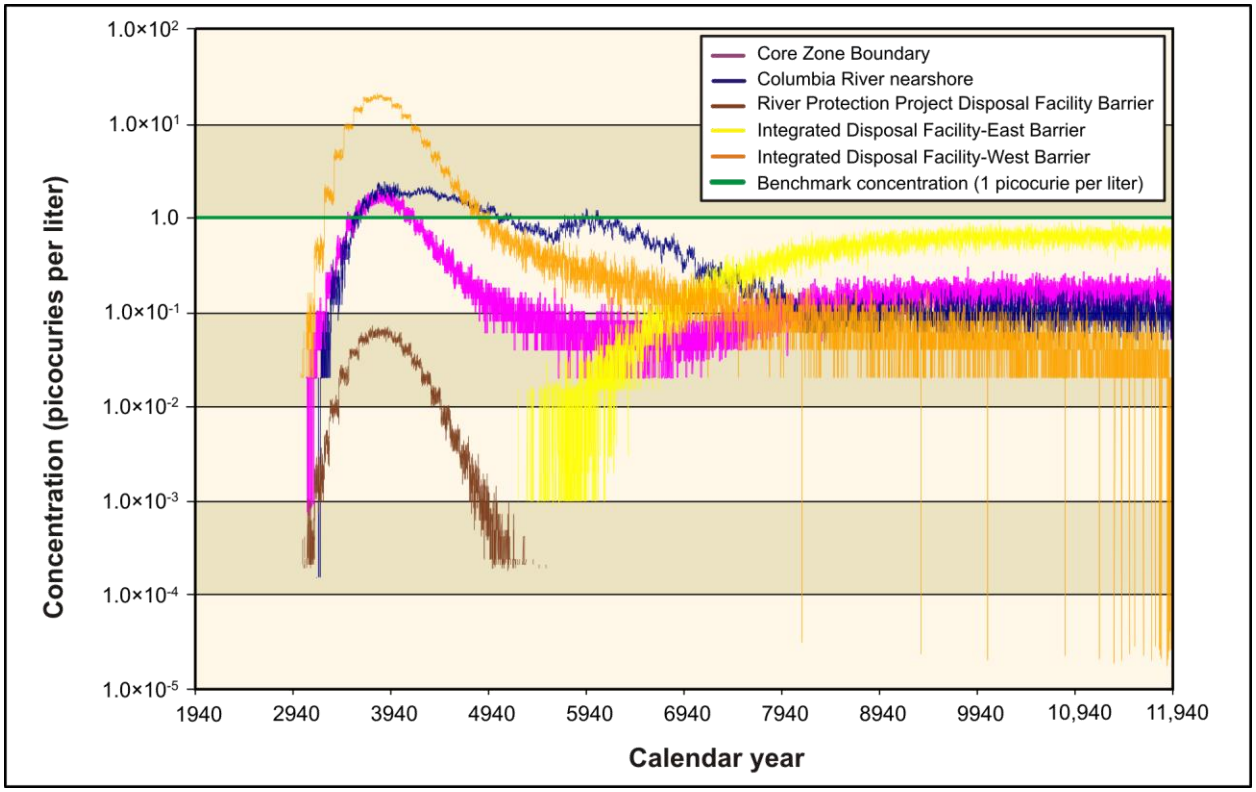


Figure 5–936. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Iodine-129 Concentration Versus Time

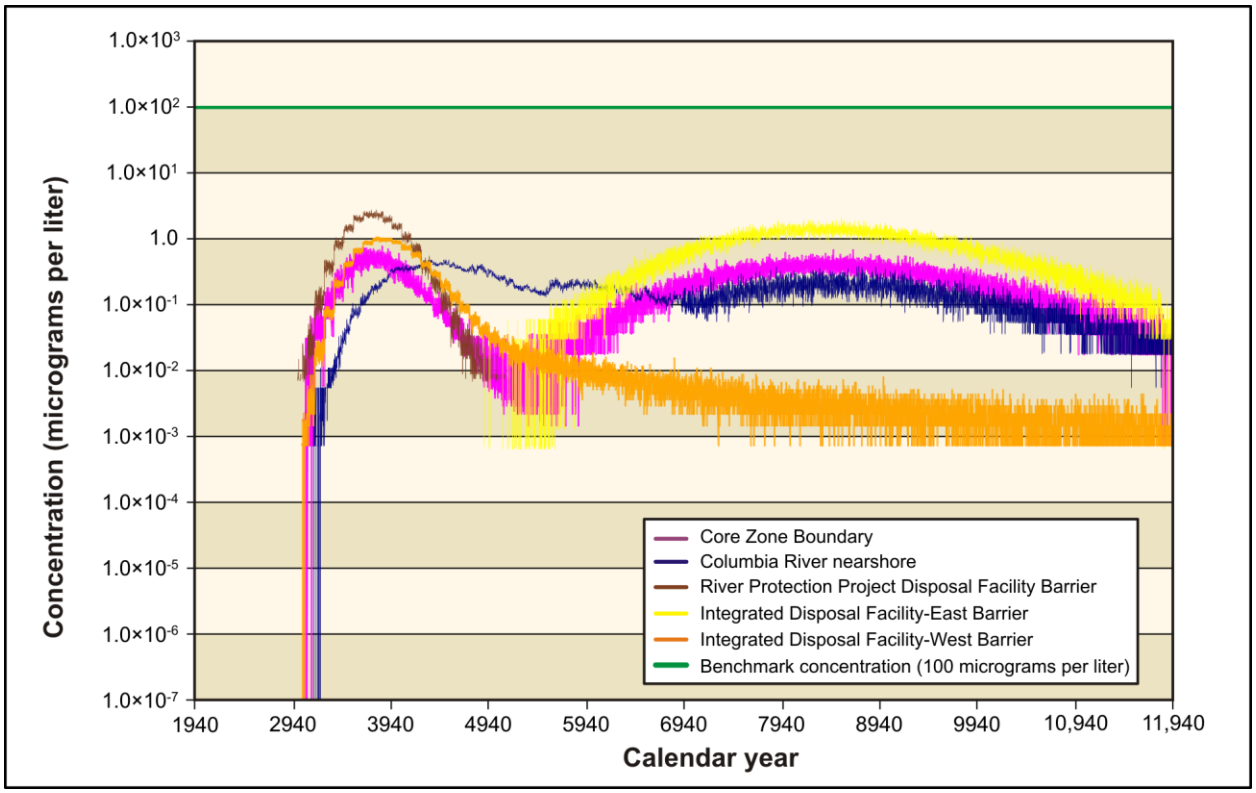


Figure 5–937. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Chromium Concentration Versus Time

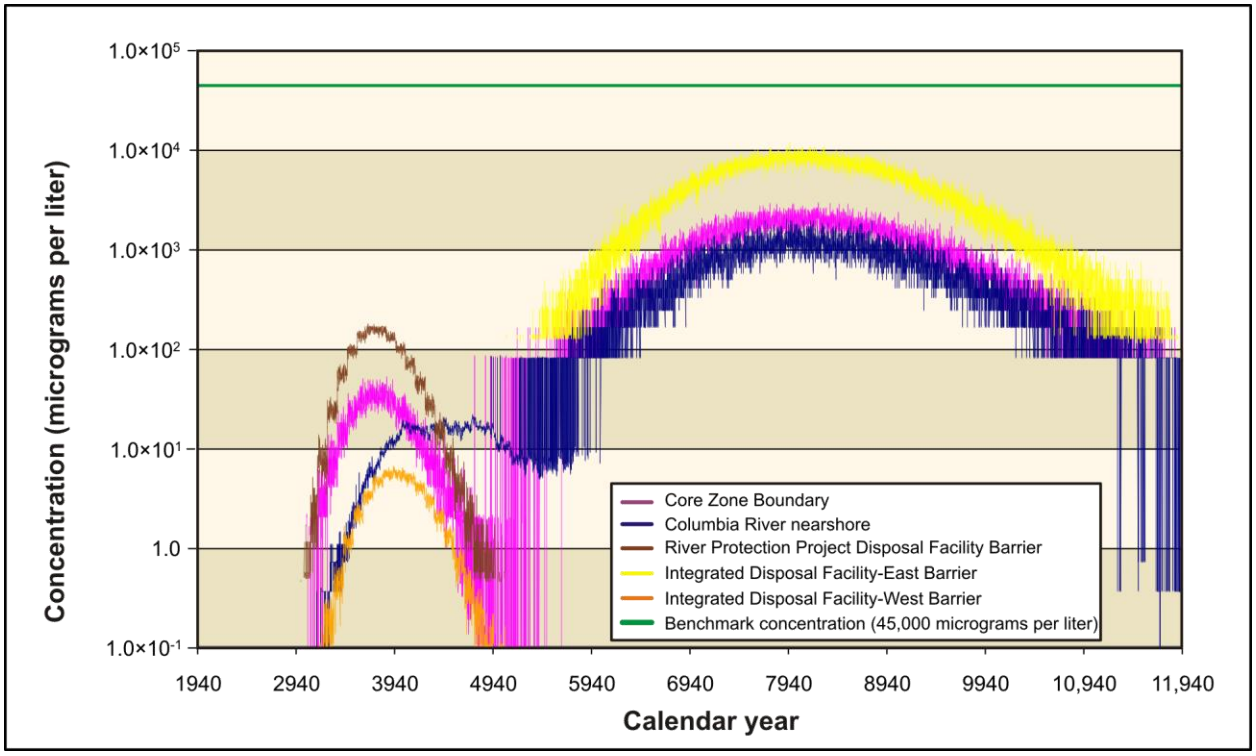


Figure 5–938. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Nitrate Concentration Versus Time

Figure 5–939 shows concentration versus time for total uranium. Because of the high retardation of uranium, no contamination appears until approximately CY 10,000, when total uranium concentrations at the RPPDF barrier first surpass 1.0×10^{-8} micrograms per liter. Total uranium remains over seven orders of magnitude below the benchmark concentration at the RPPDF barrier and Core Zone Boundary throughout the simulation.

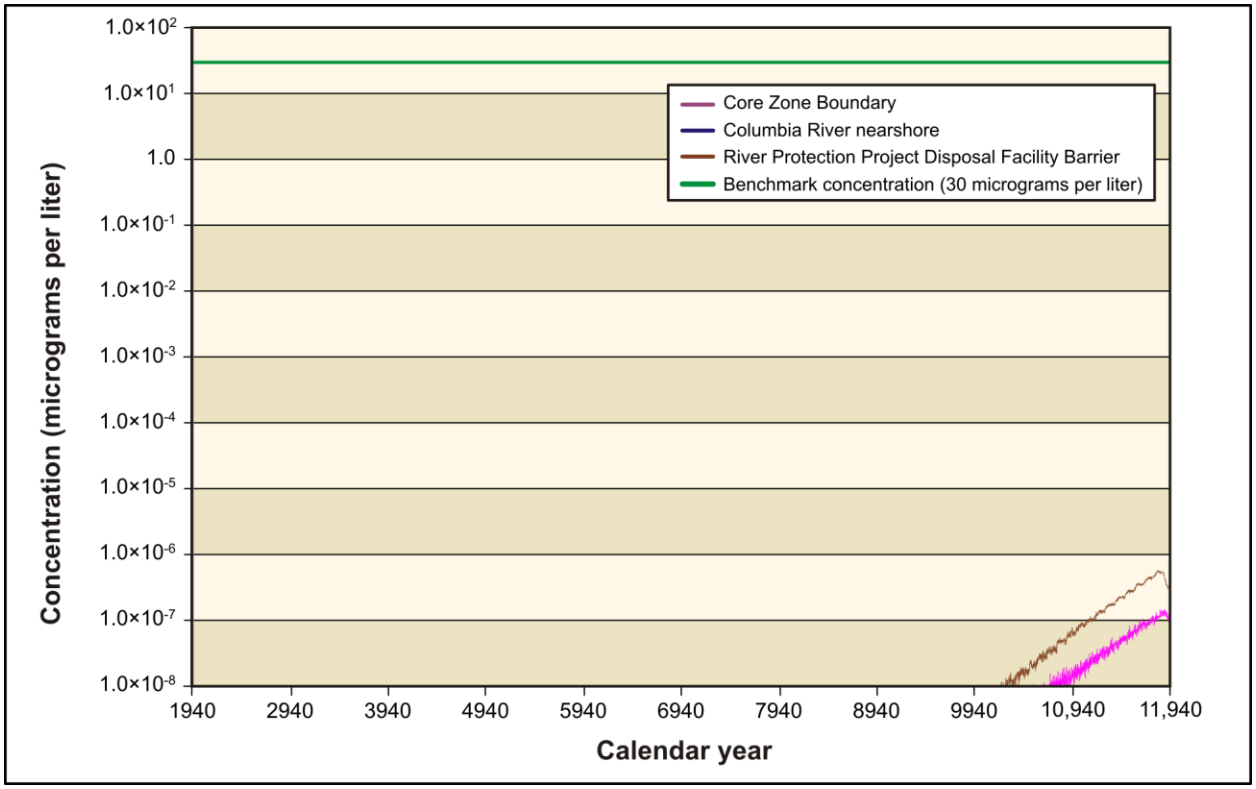


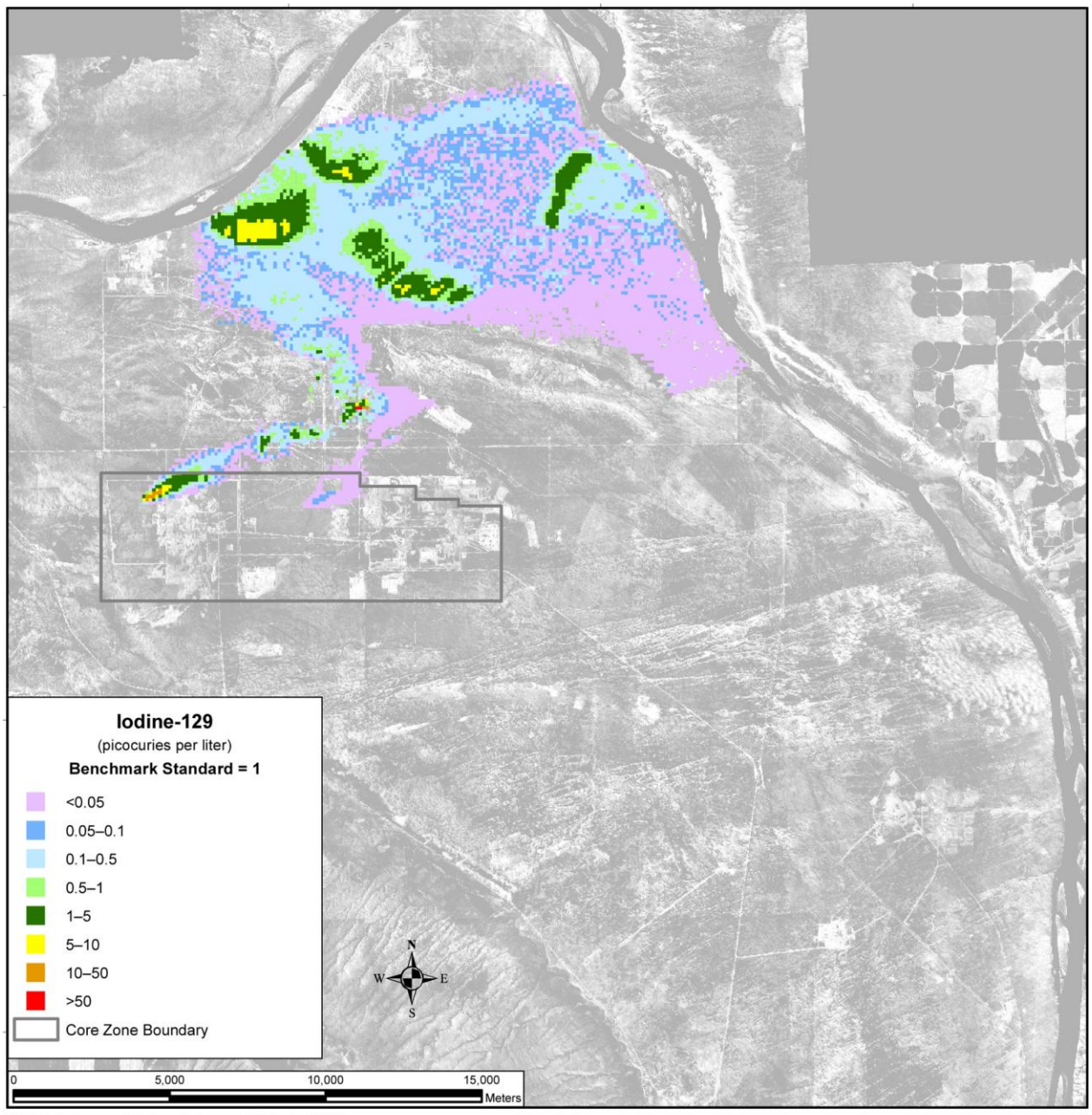
Figure 5–939. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Total Uranium Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

This section presents the impacts of Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated by the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations that vary over three orders of magnitude.

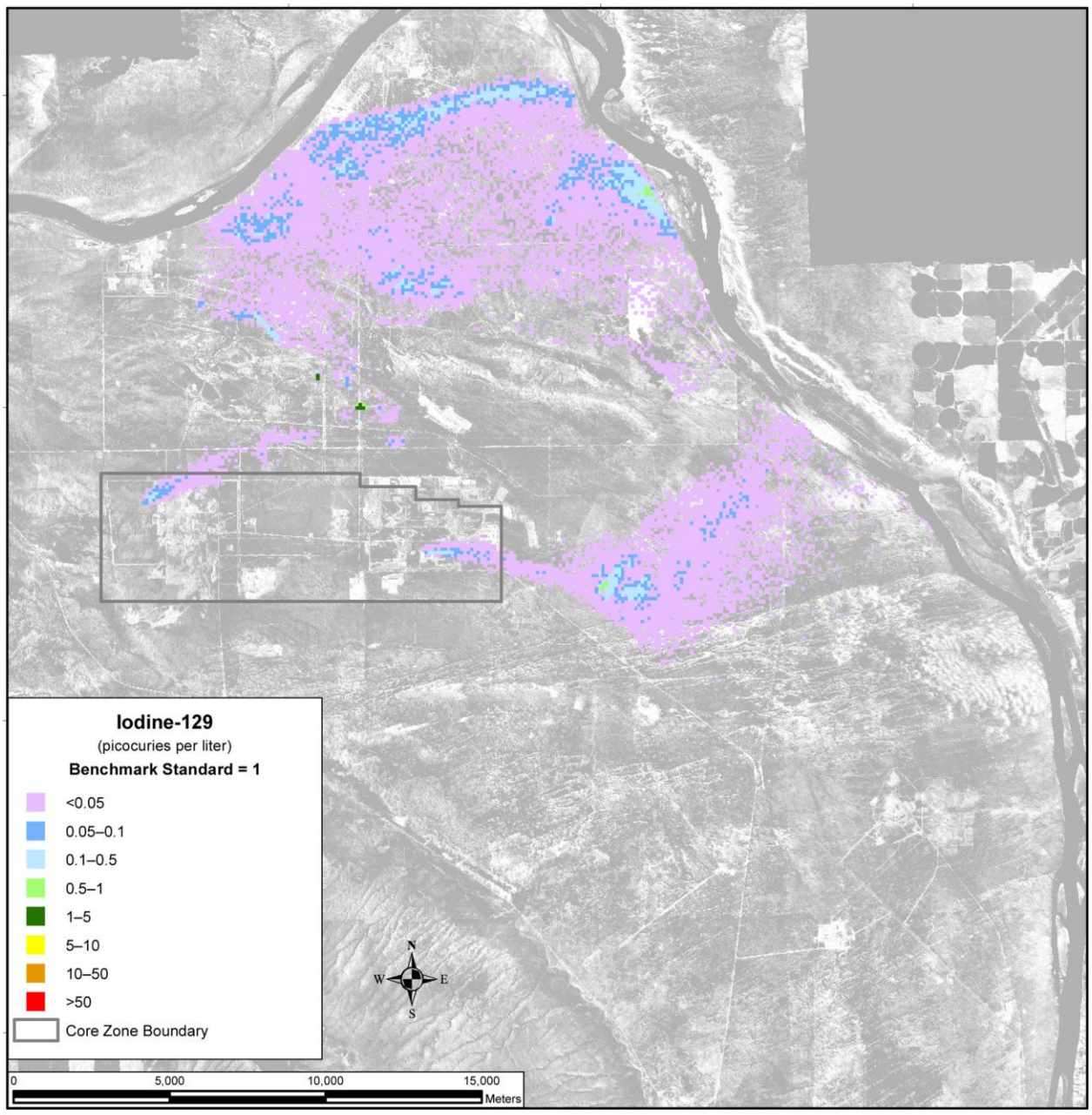
In CY 3890 (see Figure 5–940), there is a high-concentration plume of iodine-129 stretching northeast of IDF-West and a low-concentration plume stretching north from the RPPDF through Gable Gap. Four separate high-concentration areas have also formed north of Gable Mountain and Gable Butte. By CY 7140 (see Figure 5–941), the plumes from IDF-West and the RPPDF have dissipated, but a new plume has formed, traveling east from IDF-East. Concentrations in this plume remain close to the benchmark. Figure 5–942 shows the spatial concentration of iodine-129 in CY 11,885. Technetium-99 (see Figures 5–943 through 5–945) shows a similar spatial distribution, but has lower concentrations. Nitrate (see Figures 5–946 through 5–948) shows similar spatial distributions at selected times, but has

consistently lower concentrations that are well below the benchmark. Chromium (see Figures 5–949 through 5–951) has low-concentration plumes originating in IDF-East and the RPPDF in CY 3890, but no contamination originating in IDF-West until approximately CY 7140. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., they move at the pore-water velocity).



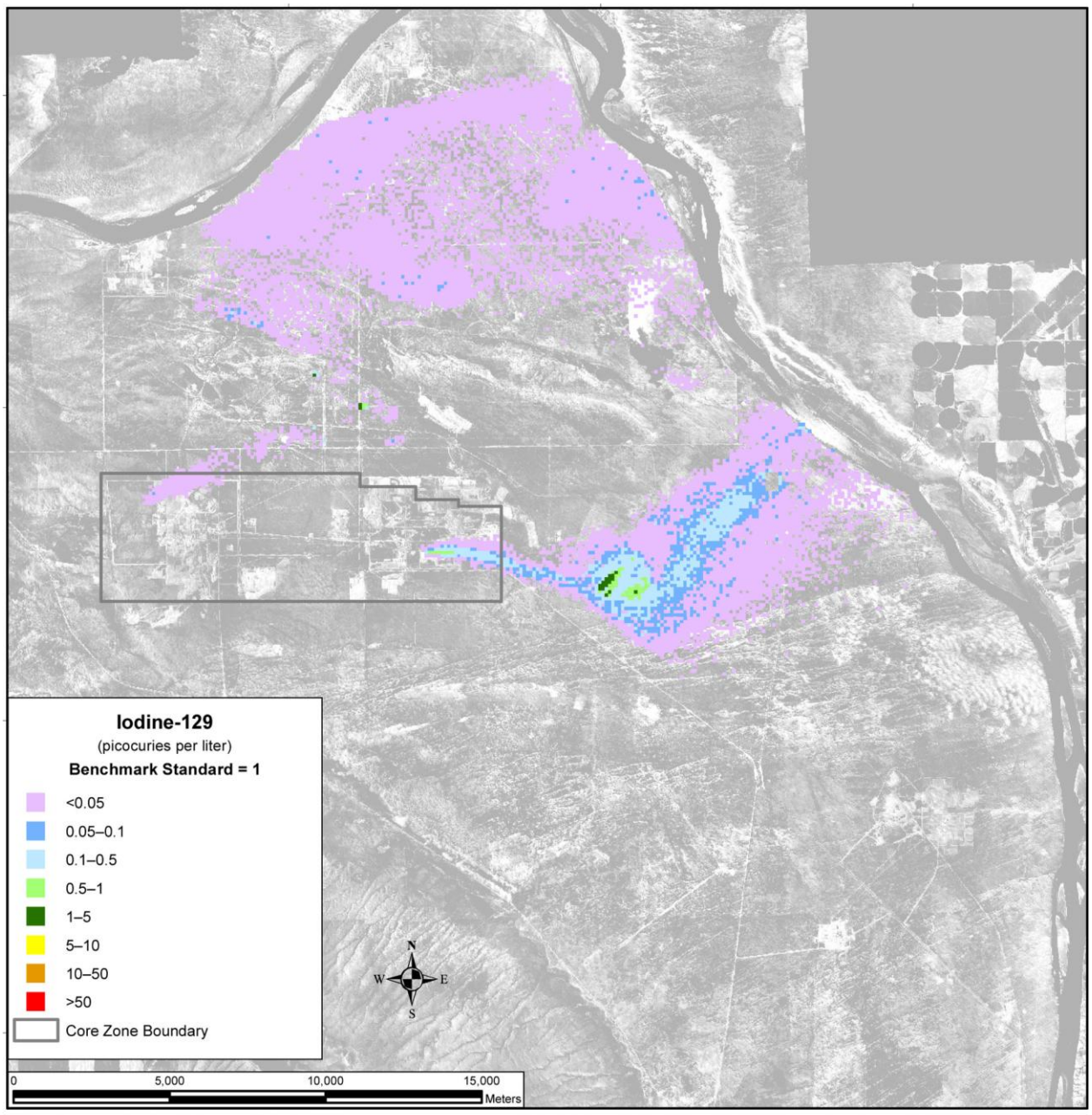
Note: To convert meters to feet, multiply by 3.281.

Figure 5–940. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



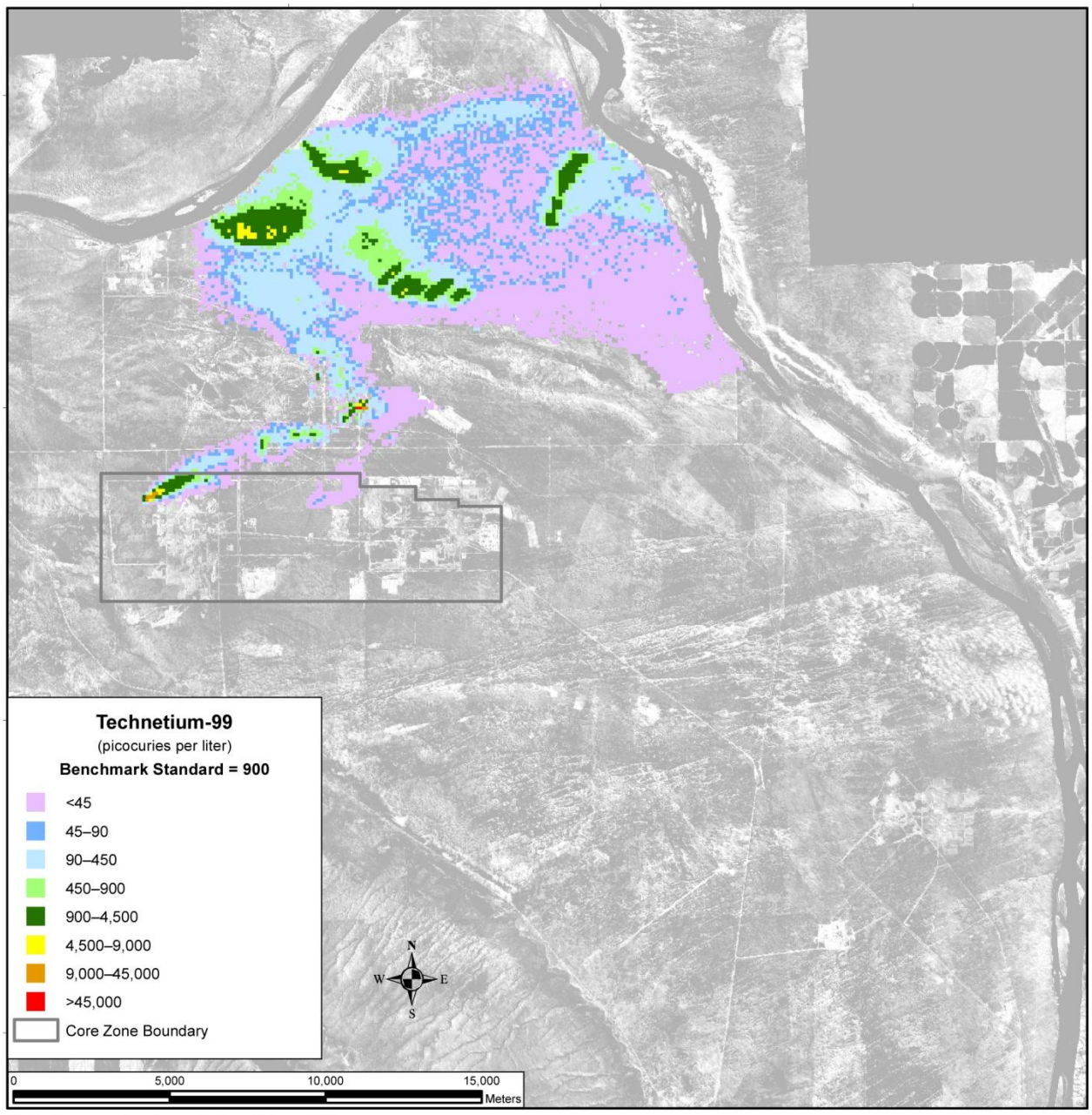
Note: To convert meters to feet, multiply by 3.281.

Figure 5–941. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



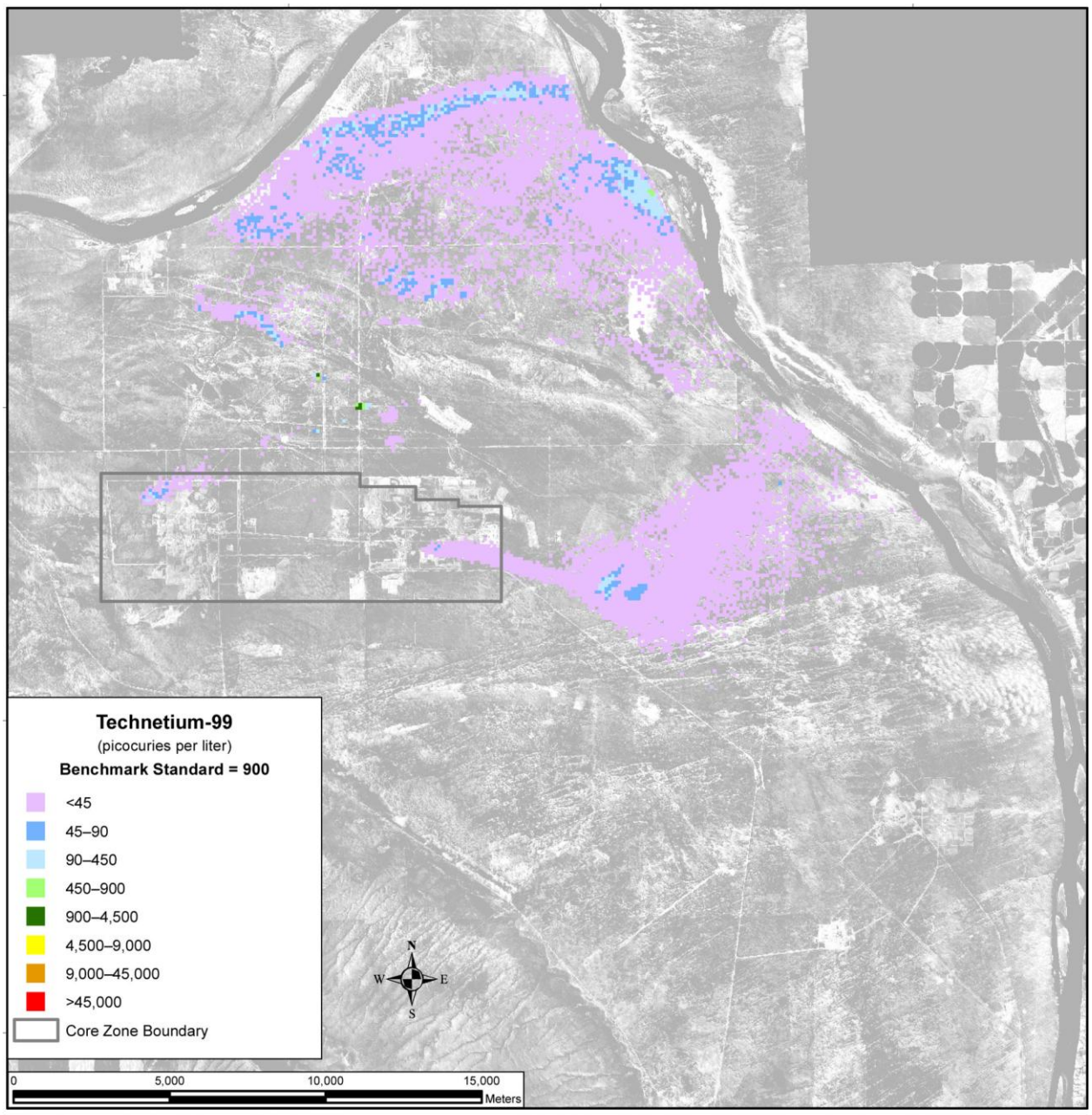
Note: To convert meters to feet, multiply by 3.281.

Figure 5–942. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



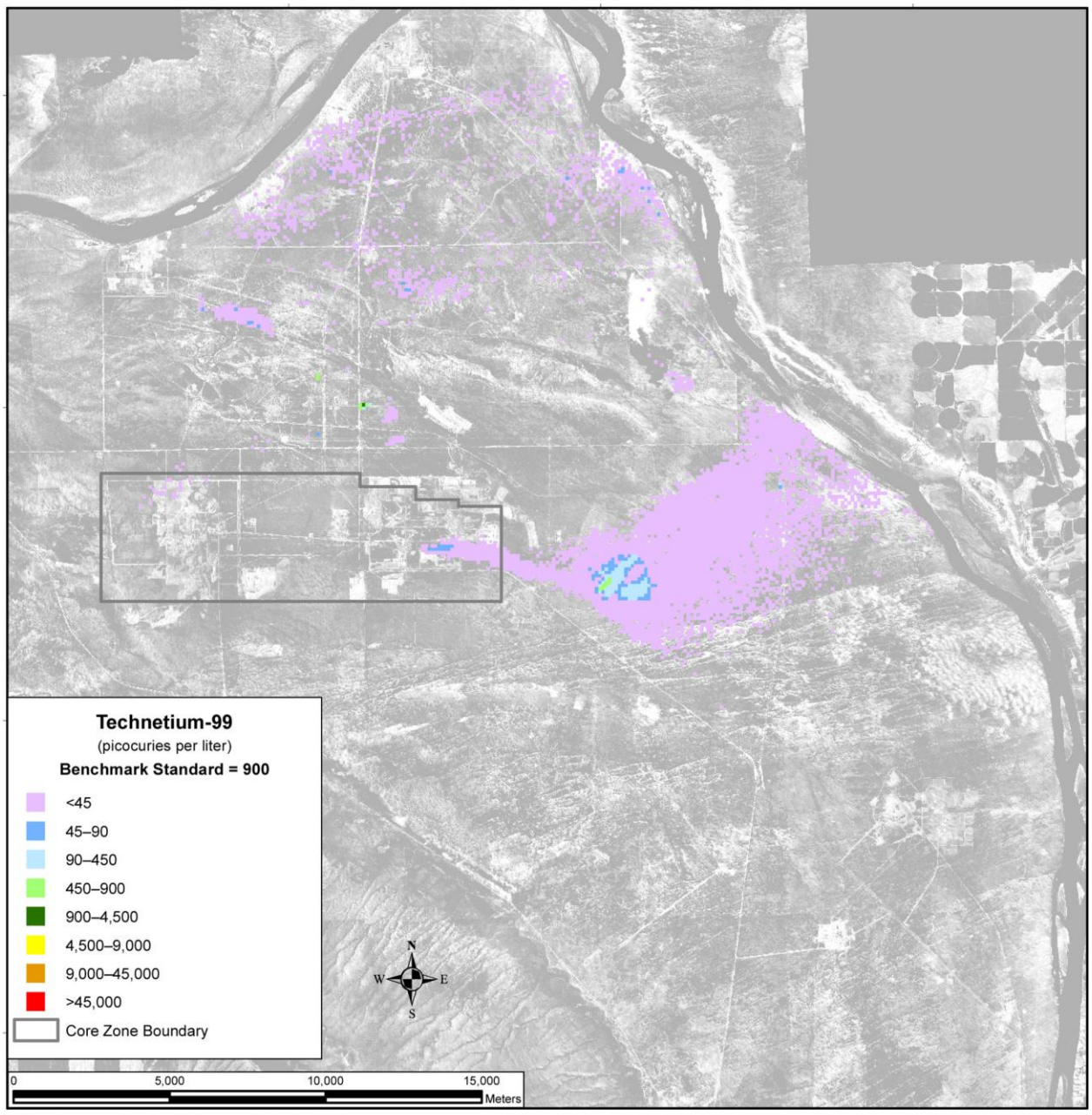
Note: To convert meters to feet, multiply by 3.281.

Figure 5–943. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



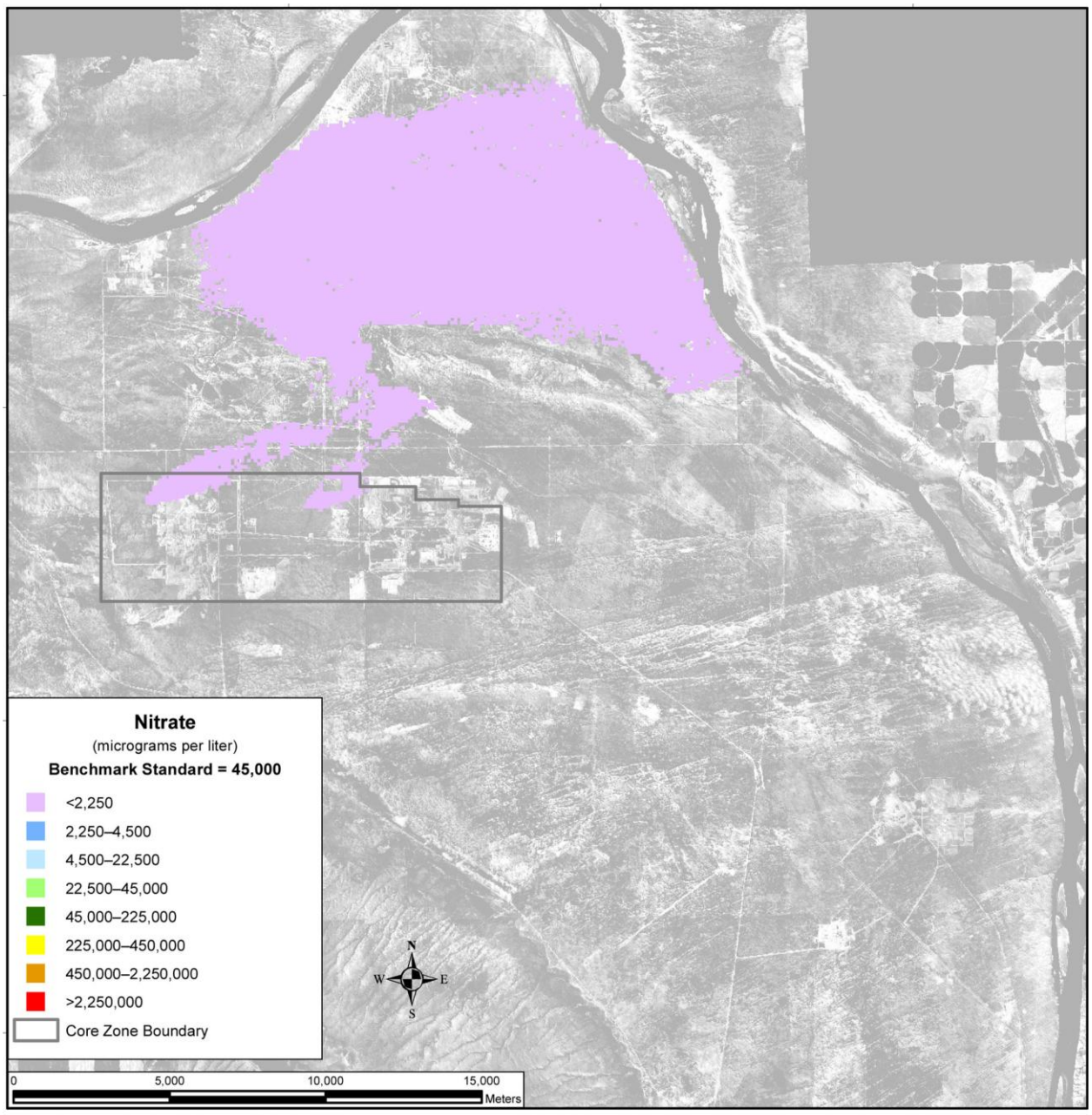
Note: To convert meters to feet, multiply by 3.281.

Figure 5–944. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



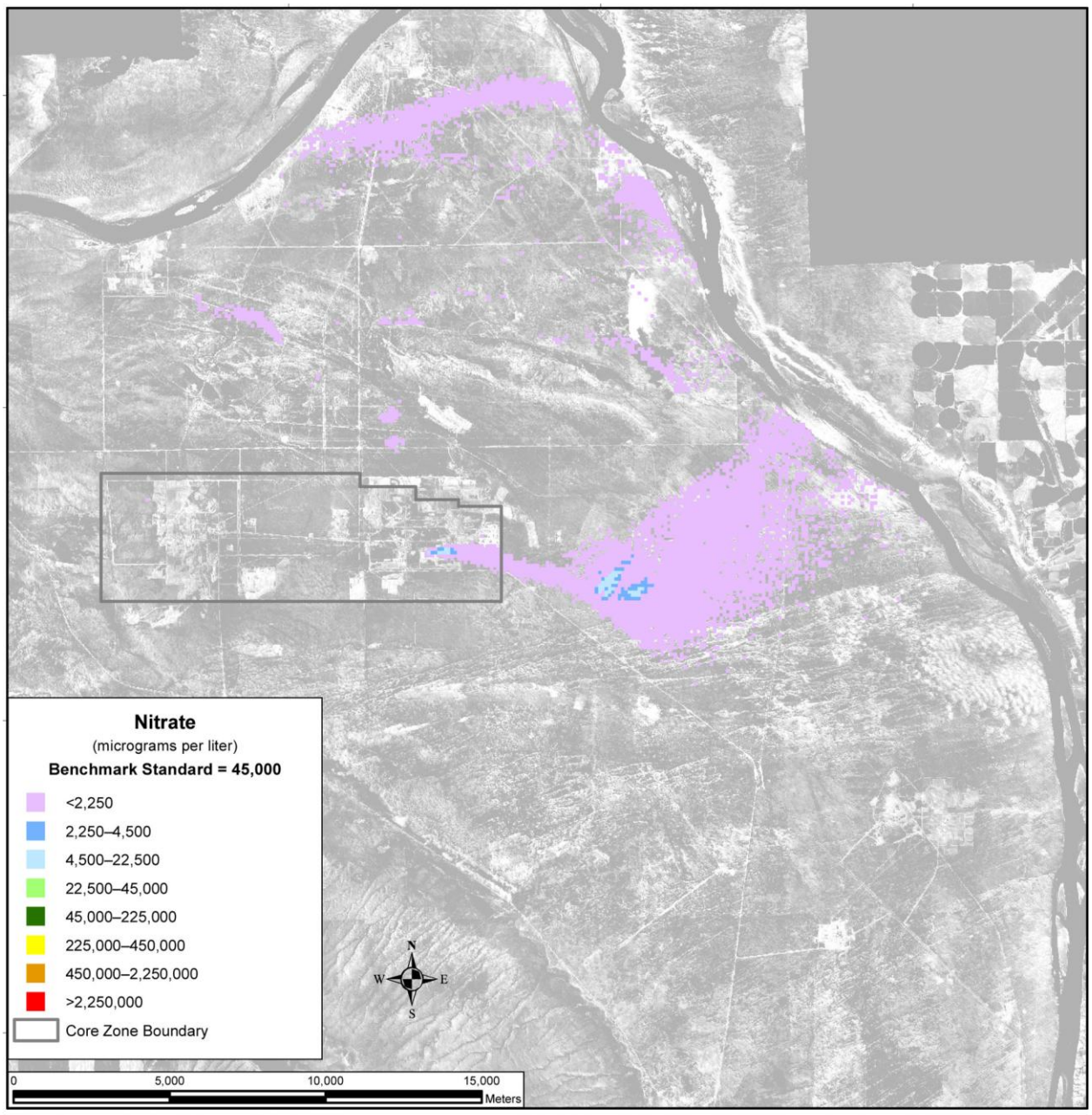
Note: To convert meters to feet, multiply by 3.281.

Figure 5–945. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



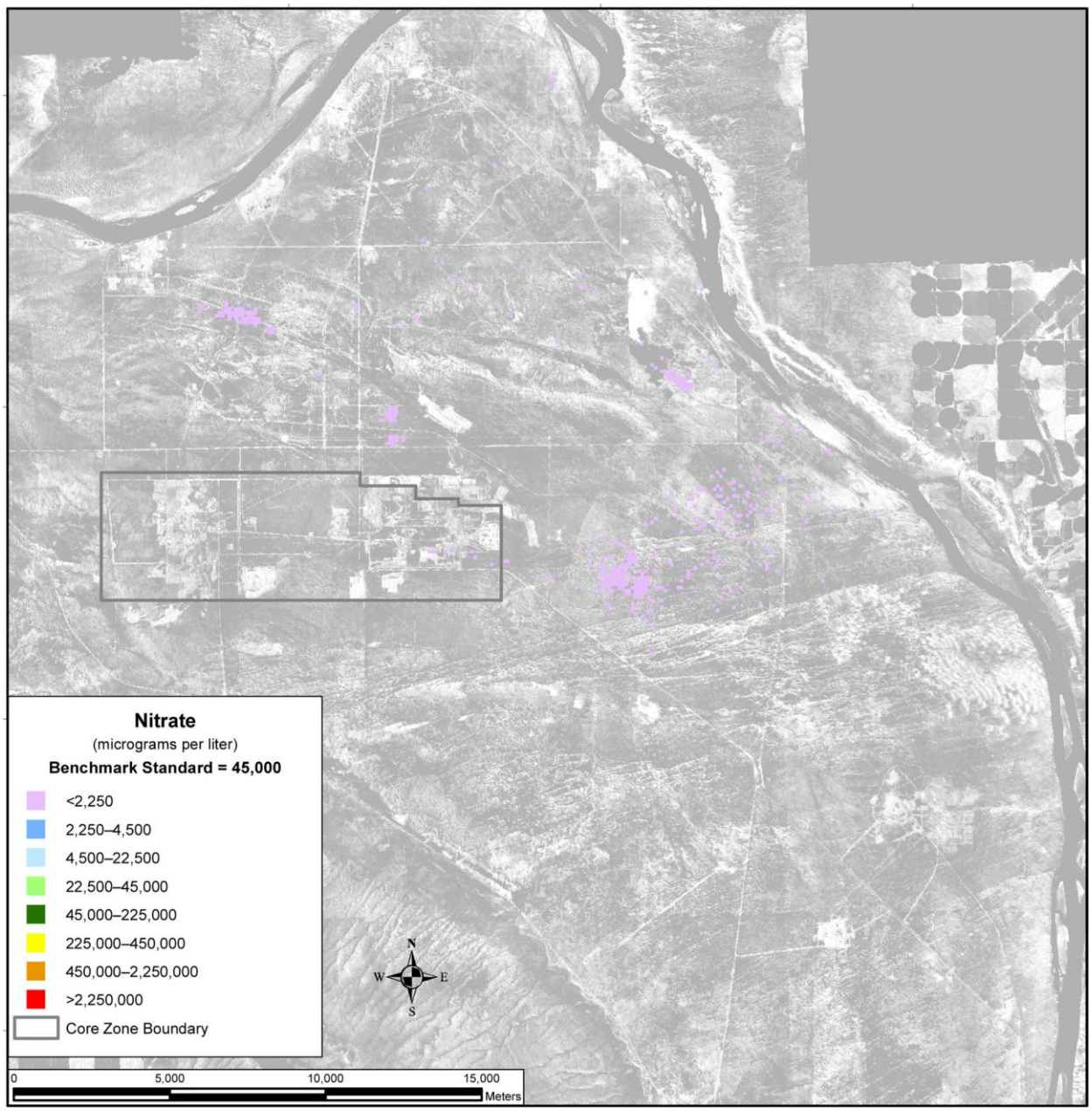
Note: To convert meters to feet, multiply by 3.281.

Figure 5–946. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



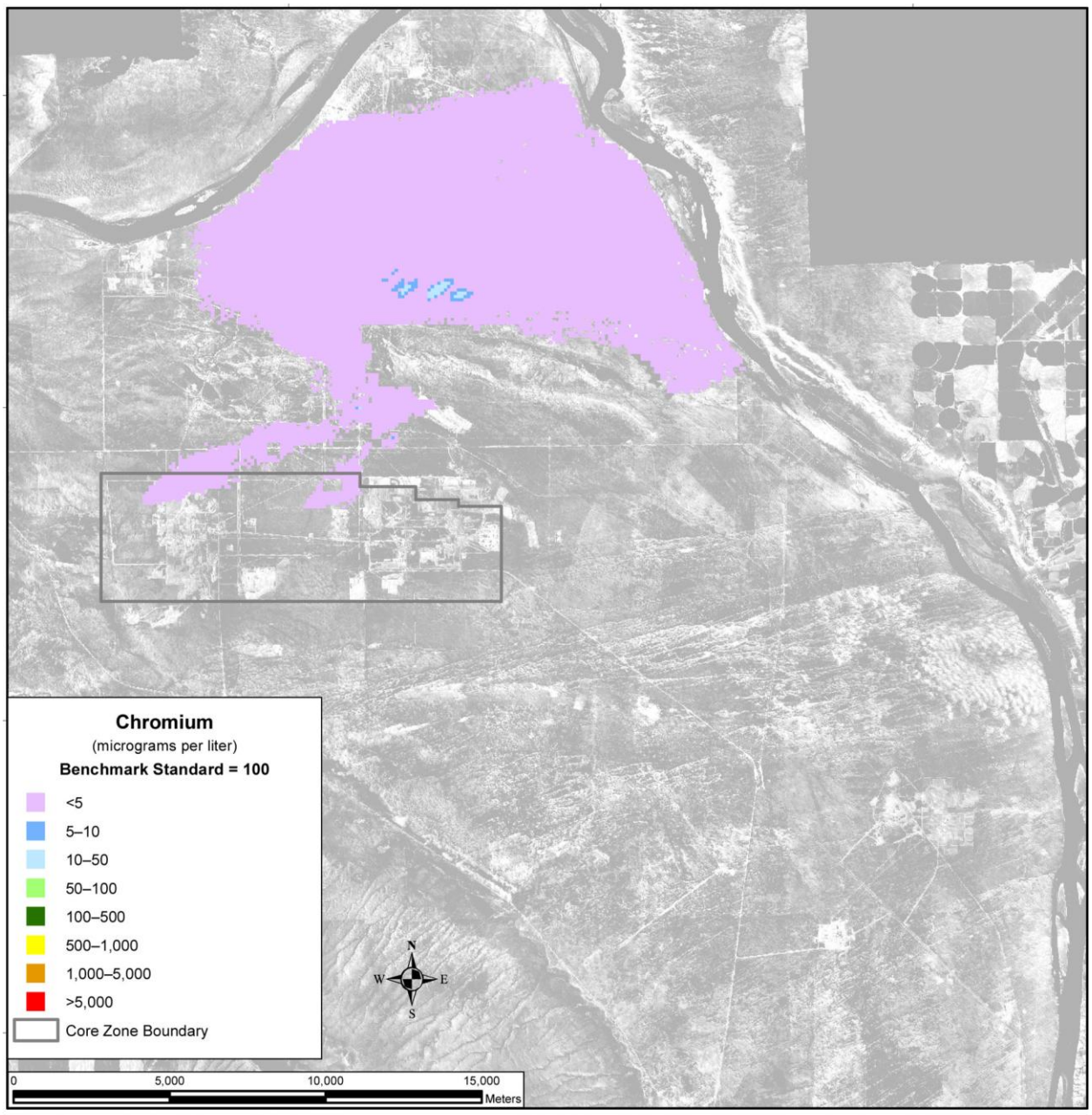
Note: To convert meters to feet, multiply by 3.281.

Figure 5–947. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



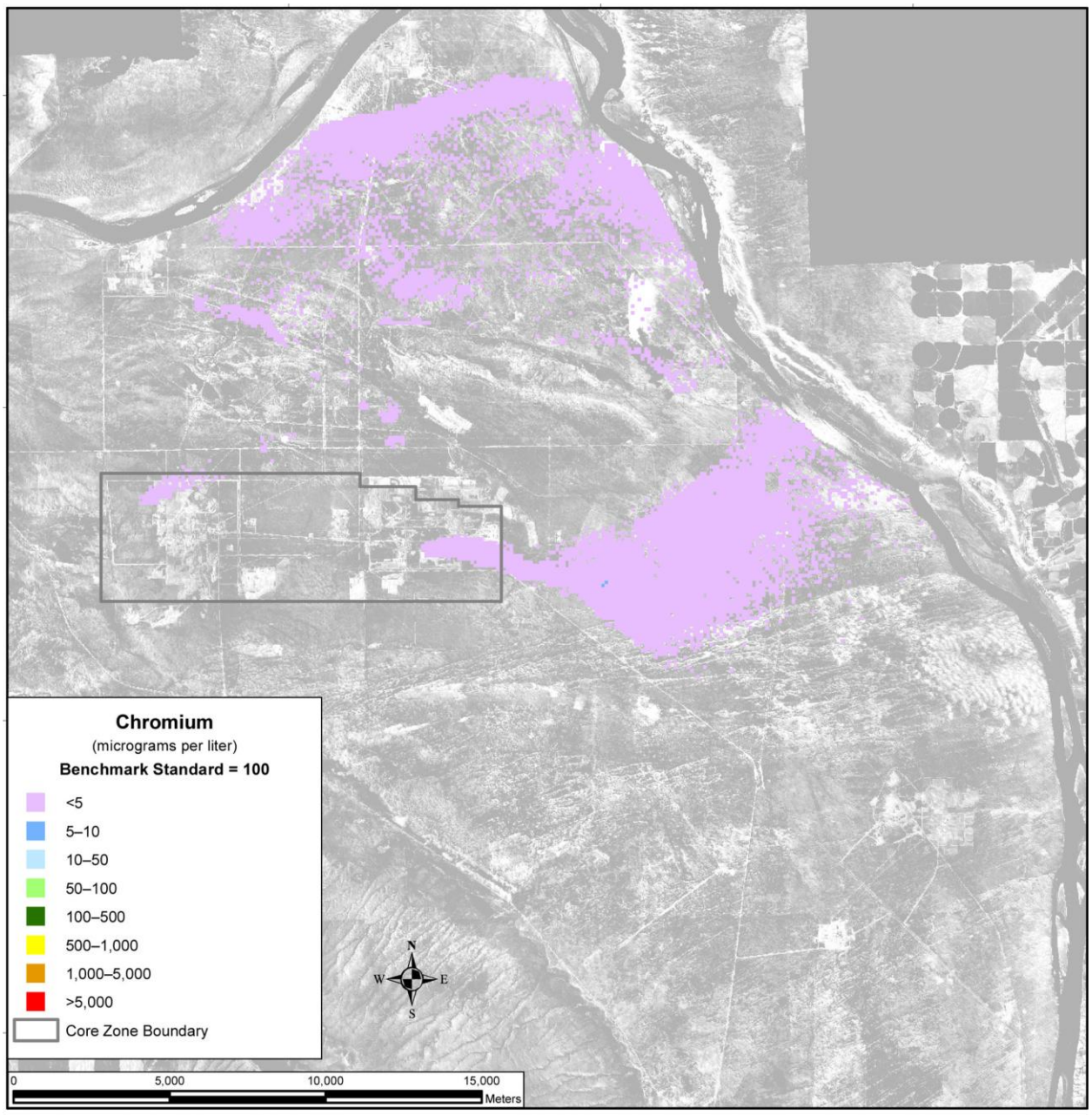
Note: To convert meters to feet, multiply by 3.281.

Figure 5–948. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885



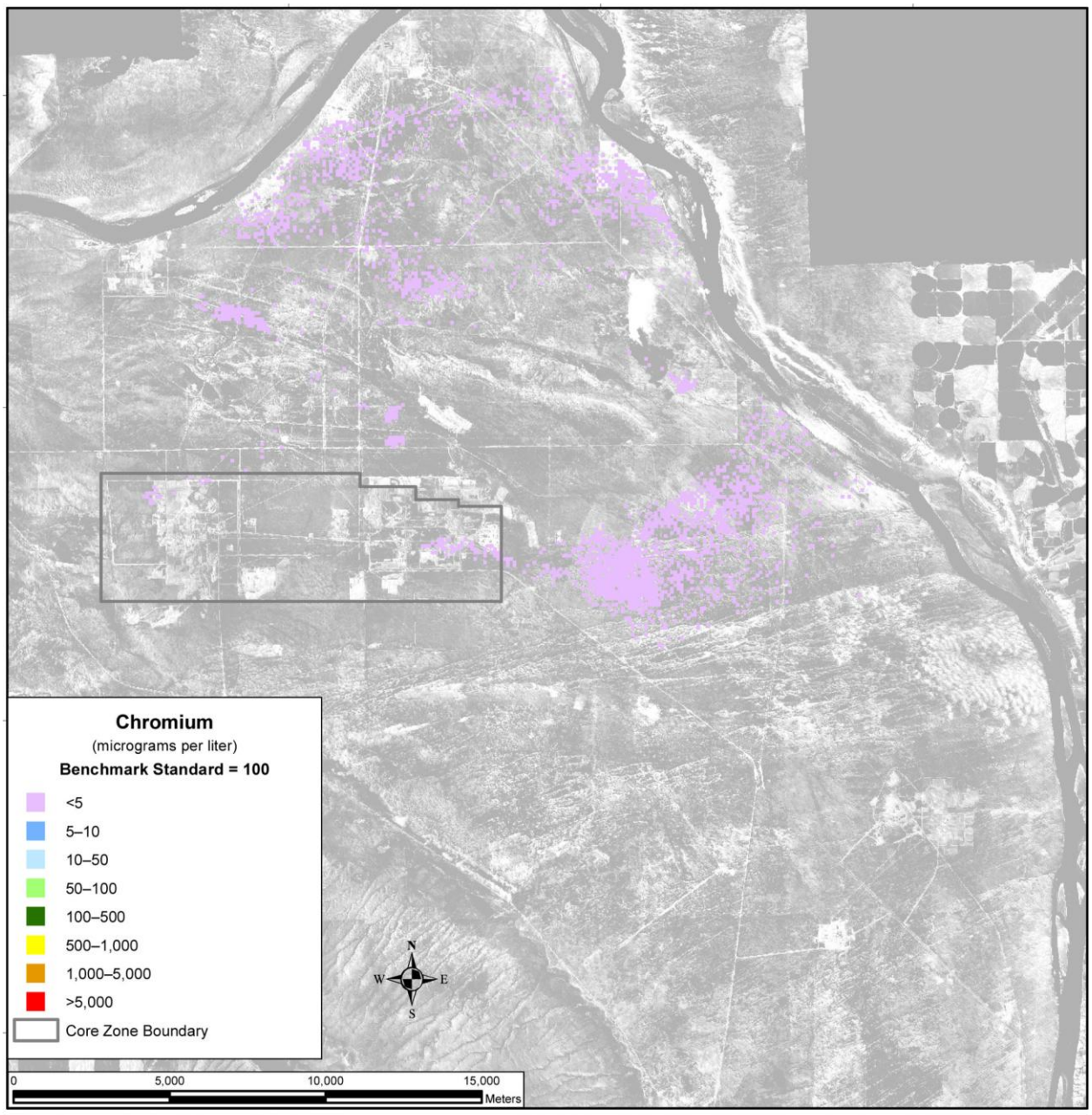
Note: To convert meters to feet, multiply by 3.281.

Figure 5–949. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

Figure 5–950. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



Note: To convert meters to feet, multiply by 3.281.

Figure 5–951. Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885

SUMMARY OF IMPACTS

Under Waste Management Alternative 3, Disposal Group 1, Subgroup 1-G, in general, discharges from IDF-West are predominant contributors. IDF-East and the RPPDF are secondary contributors.

Concentrations of iodine-129 and technetium-99 show a sharp rise and fall between CY 2940 and CY 4940 that exceeds the benchmark by an order of magnitude or slightly more. Concentrations of these COPCs stabilize near the benchmark concentration around CY 7940. Chromium shows a similar rise and fall but remains about two orders of magnitude below the benchmark. Nitrate has a similar rise and fall in concentrations between CY 2940 and CY 4940, followed by another rise in concentrations. This rise in

concentration stabilizes around CY 6940 and is about an order of magnitude greater than the first peak, but an order of magnitude below the benchmark concentration.

For uranium-238 and total uranium, limited mobility is an important factor governing the timeframe and scale of groundwater impacts. The concentrations of these retarded species remain well below the benchmark at the Core Zone Boundary and the Columbia River nearshore throughout the 10,000-year period of analysis. The intensity is highest and the area of the contamination plumes largest near the end of the period of analysis.

5.3.1.3.2 Disposal Group 2

Disposal Group 2 is characterized by operational completion dates of CY 2100 for IDF-East and the RPPDF and CY 2050 for IDF-West. Under Disposal Group 2, IDF-West would have a large capacity (90,000 cubic meters [117,720 cubic yards]); IDF-East, a larger capacity (325,000 cubic meters [425,100 cubic yards]); and the RPPDF, an even larger capacity (8,370,000 cubic meters [10,947,960 cubic yards]). These capacities were designed to meet the waste generation volumes associated with Tank Closure Alternative 2A or 6B and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste.

5.3.1.3.2.1 Disposal Group 2, Subgroup 2-A

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, was designed to accommodate the disposal of wastes generated under Tank Closure Alternative 2A and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste.

For the long-term groundwater impacts analysis, two major periods have been identified for Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, as follows:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East and IDF-West in CY 2009 and continue through CY 2100 for IDF-East and through CY 2050 for IDF-West, when these disposal facilities would be operationally closed. During the disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2101 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in IDF-East and IDF-West would become available for release to the environment, and it was assumed for analysis purposes that barriers would be emplaced over the facilities to limit infiltration during the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, is focused on the following COPC drivers:

- Radiological risk drivers: iodine-129 and technetium-99
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, fluoride, and nitrate

The COPC drivers for Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. The radiological risk drivers listed above account for essentially 100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard drivers above account for over 99 percent of the chemical hazard associated with Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, chromium, fluoride, and nitrate) are all mobile (i.e., they move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, in terms of the total amount of COPCs released from IDF-East and IDF-West to the vadose zone, groundwater, and the Columbia River during the 10,000-year period of analysis. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over 10 orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

Four subtotals are plotted in Figures 5–952 through 5–957, representing releases from IDF- East, which include ILAW glass, ETF-generated secondary waste, retired melters, and tank closure secondary waste.

Figure 5–952 shows the estimated release to the vadose zone of the radiological risk drivers and Figure 5–953, the chemical hazard drivers. For technetium-99, chromium, and nitrate in grouted waste forms, the release to the vadose zone is controlled by the inventory (i.e., nearly all of the inventory is released during the post-disposal period). The predominant source of technetium-99 and chromium is tank closure secondary waste. Iodine-129 and nitrate have ETF-generated secondary waste as the predominant source. Fluoride is not released from IDF-East.

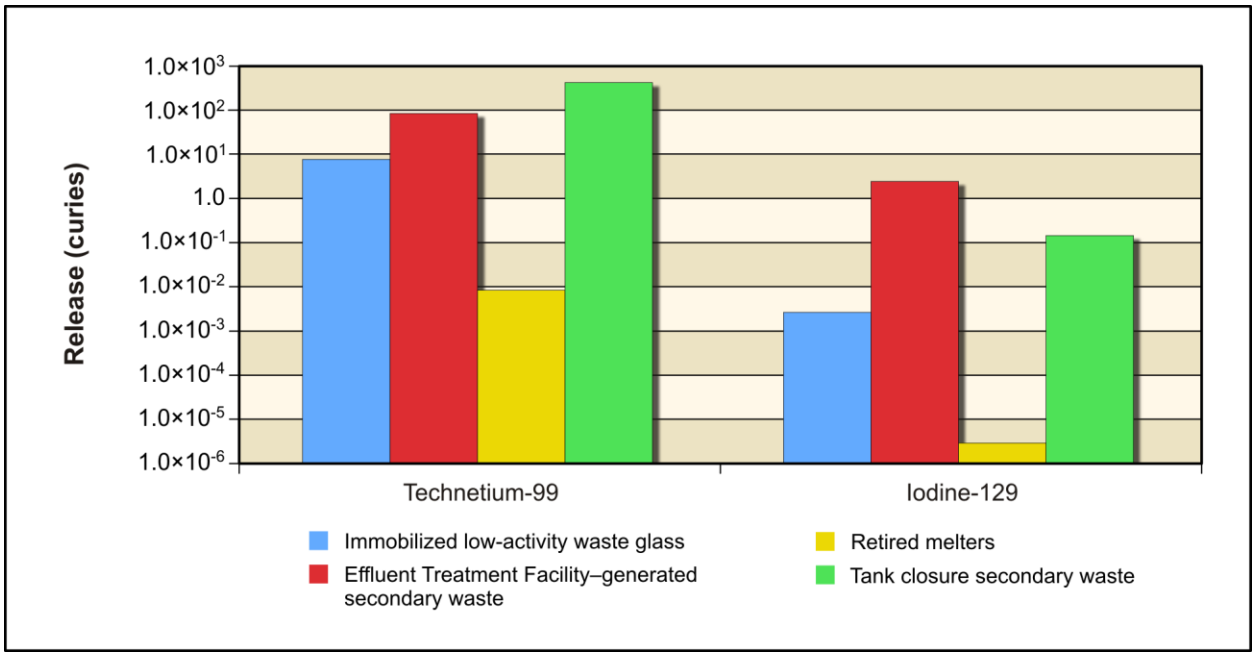


Figure 5–952. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

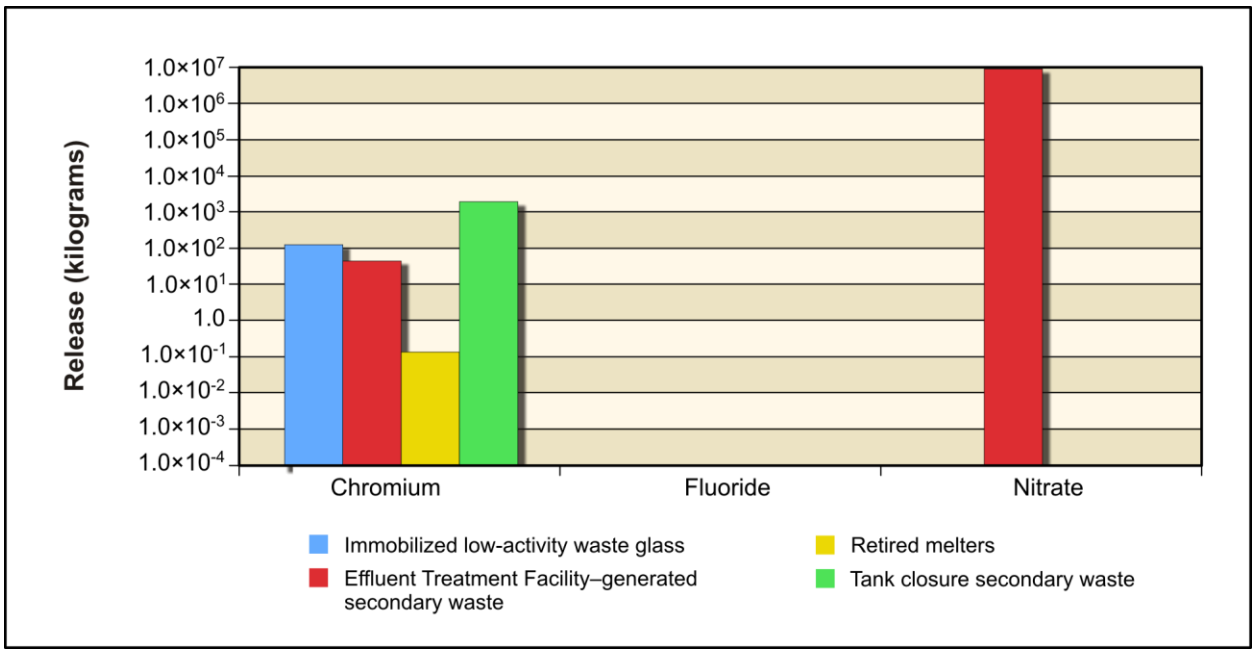


Figure 5–953. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–954 shows the estimated release to groundwater of the radiological risk drivers and Figure 5–955, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For iodine-129 and technetium-99, the amount released to groundwater is 42 percent and 59 percent, respectively. For chromium and nitrate, the amount released to groundwater is essentially equal to the amount released to the vadose zone. Overall, about 59 percent of the radionuclide amount (curies) released to the vadose zone during the period of

analysis reaches groundwater, while approximately 100 percent of the chemical quantity (kilograms) released to the vadose zone during the period of analysis reaches groundwater.

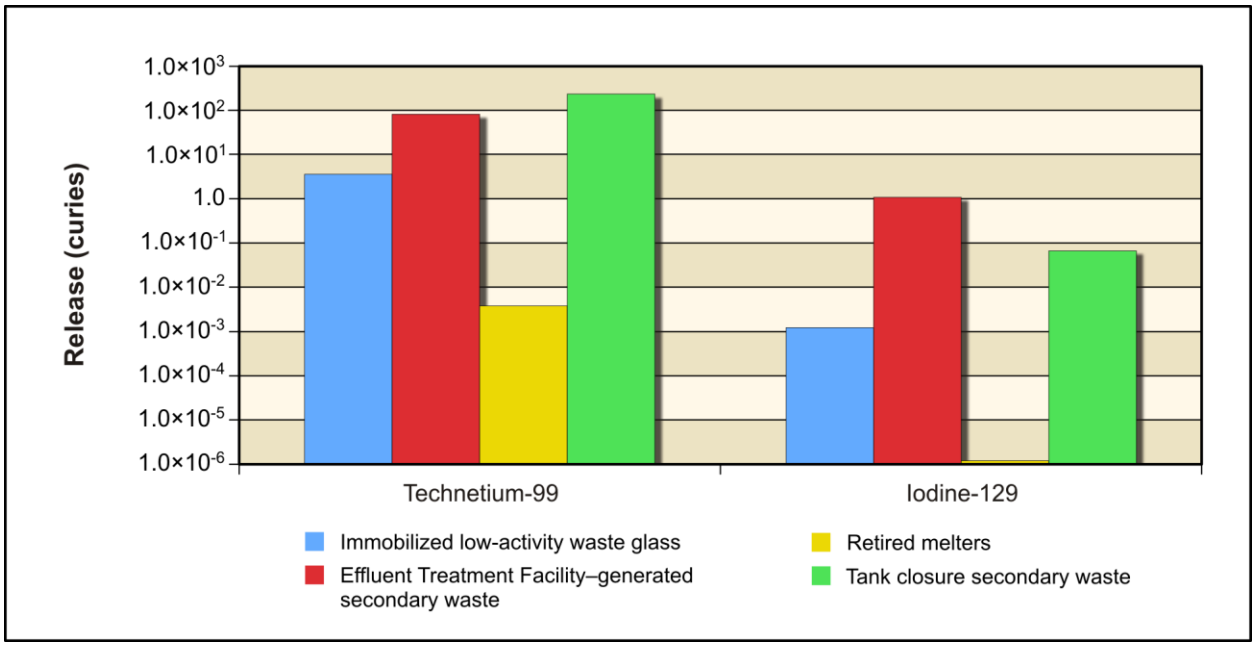


Figure 5–954. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

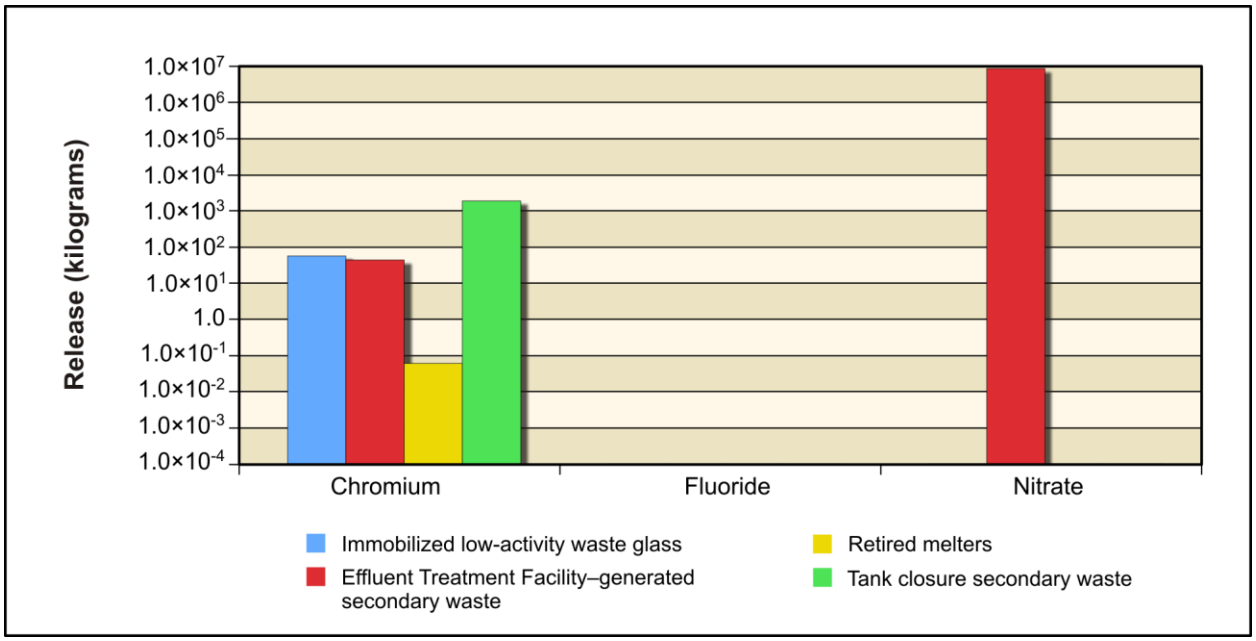


Figure 5–955. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–956 shows the estimated release to the Columbia River of the radiological risk drivers and Figure 5–957, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For technetium-99, iodine-129, chromium, and nitrate, the amount released to the Columbia River is essentially equal to the amount released to groundwater. About 96 percent of the radionuclide amount (curies) released to groundwater during the period of analysis

reaches the river, while approximately 99 percent of the chemical quantity (kilograms) released to groundwater during the period of analysis reaches the river.

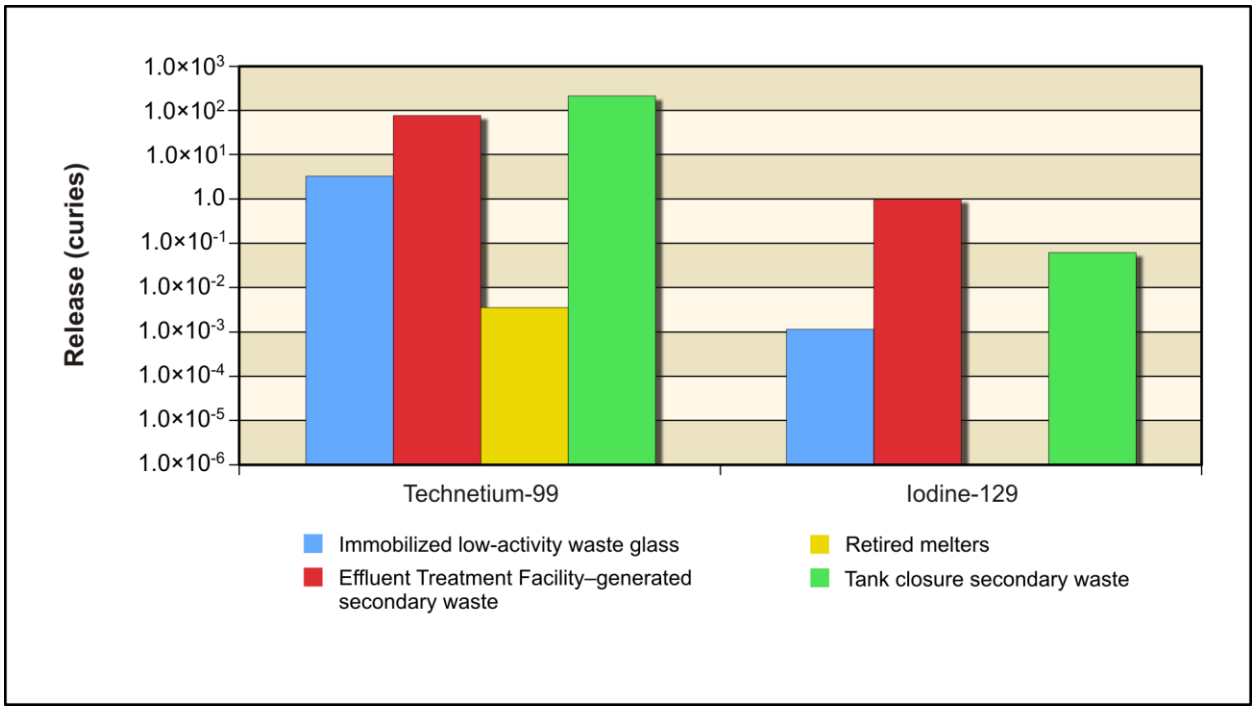


Figure 5–956. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

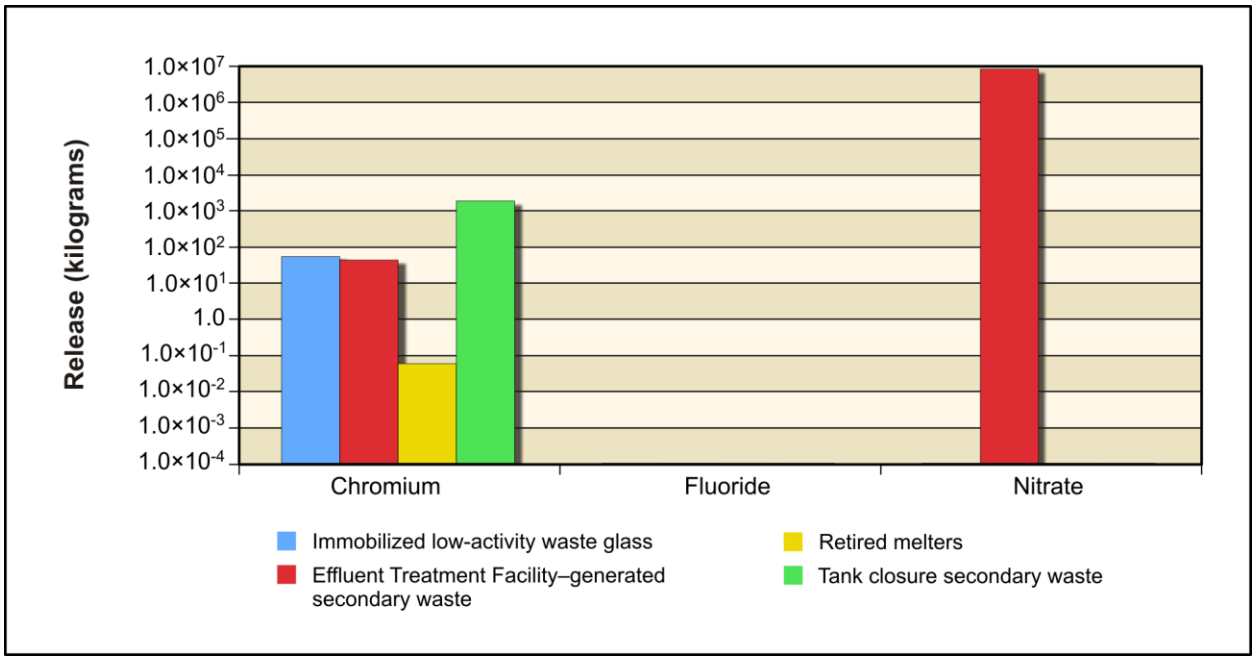


Figure 5–957. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

200-West Area Integrated Disposal Facility

Three subtotals are plotted in Figures 5–958 through 5–963, representing releases from IDF-West, which include FFTF Decommissioning Alternative 3 waste, waste management secondary and onsite waste, and offsite waste.

Figure 5–958 shows the estimated release to the vadose zone of the radiological risk drivers and Figure 5–959, the chemical hazard drivers. For all three types of sources, the release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). The predominant source of technetium-99 and iodine-129 is offsite waste. For chromium, nitrate, and fluoride, the predominant source is waste management secondary and onsite waste.

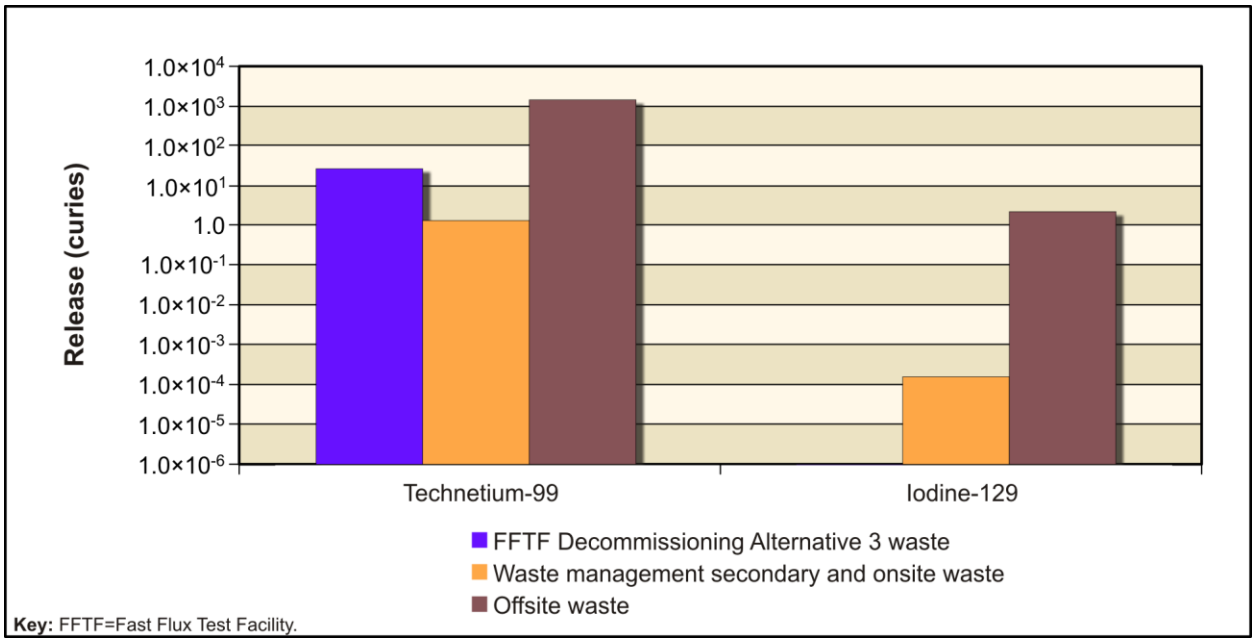


Figure 5–958. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

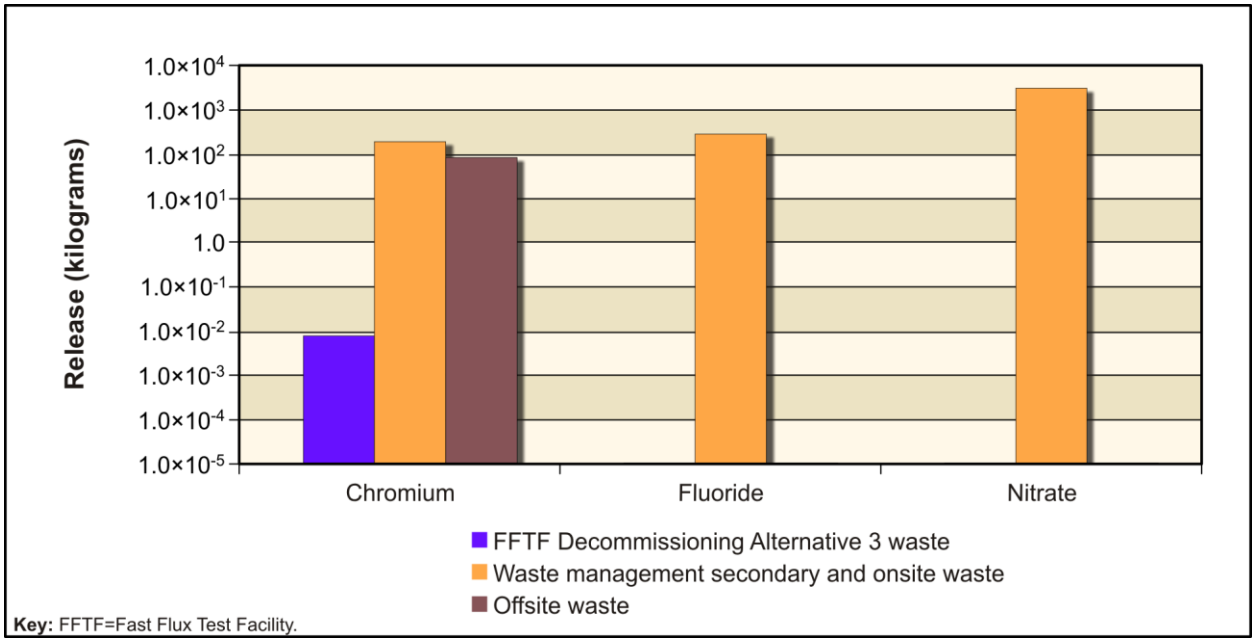


Figure 5–959. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Chemical Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

Figure 5–960 shows the estimated release to groundwater of the radiological risk drivers and Figure 5–961, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For iodine-129, technetium-99, chromium, nitrate, boron, and fluoride, the amount released to groundwater is essentially equal to the amount released to the vadose zone. Overall, about 98 percent of the radionuclide amount (curies) released to the vadose zone during the period of analysis reaches groundwater, while approximately 100 percent of the chemical quantity (kilograms) released to the vadose zone during the period of analysis reaches groundwater.

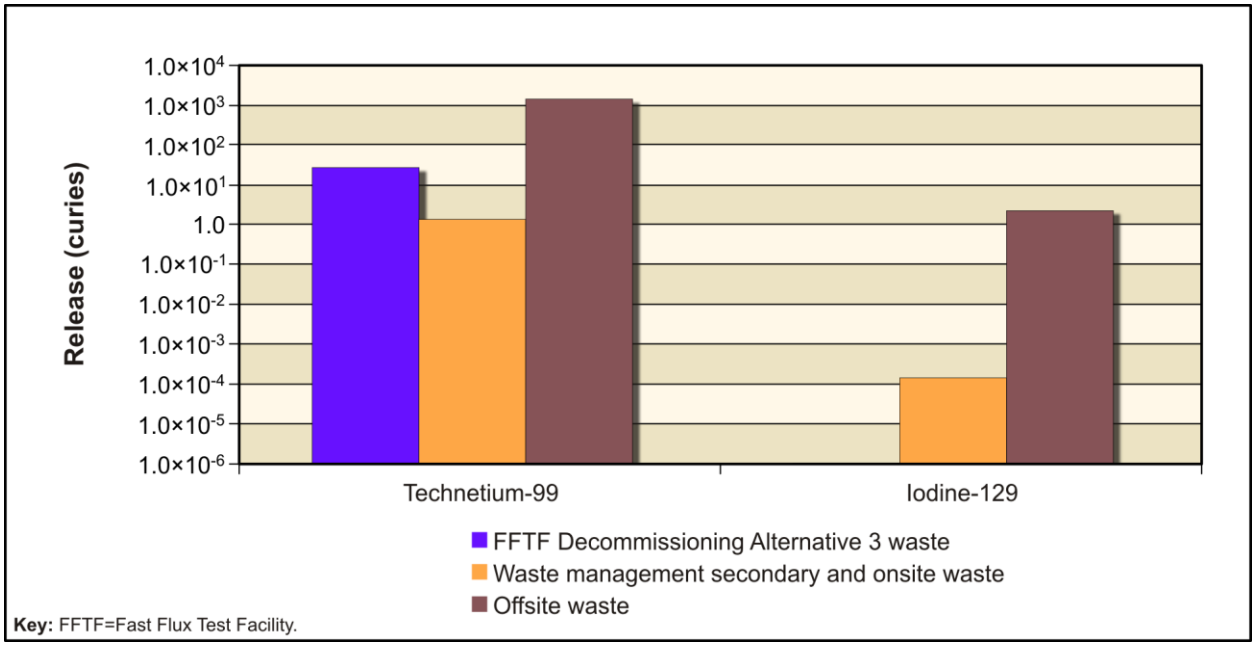


Figure 5–960. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Groundwater

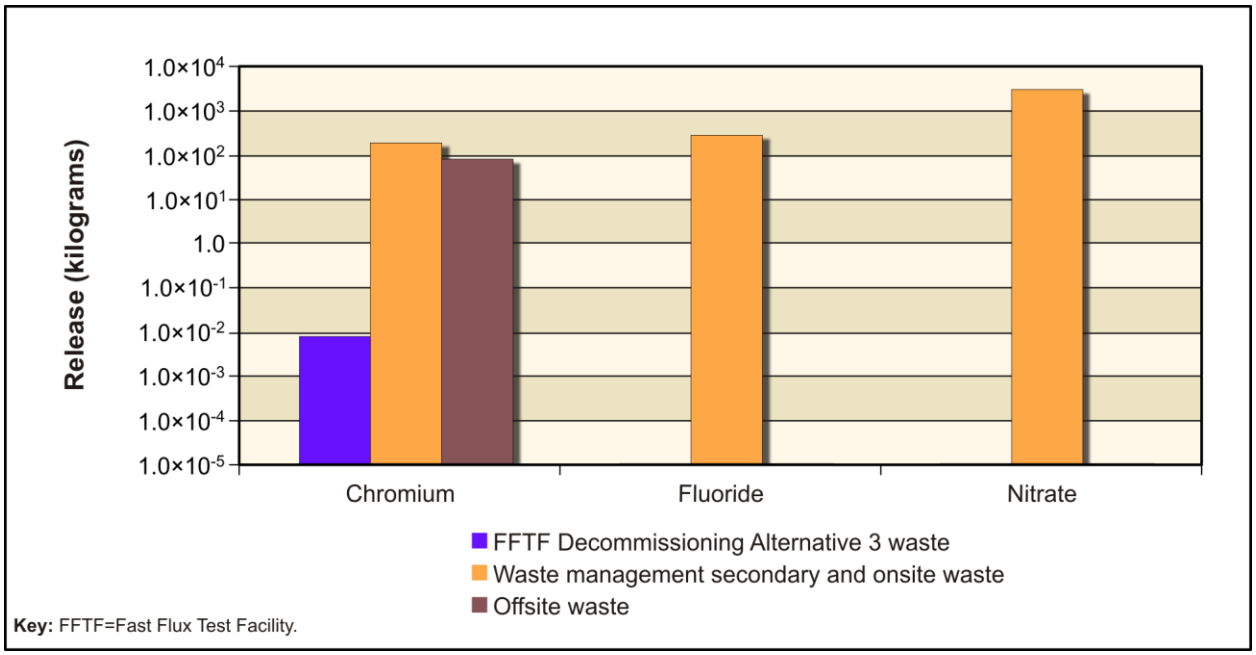


Figure 5–961. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Chemical Releases from 200-West Area Integrated Disposal Facility to Groundwater

Figure 5–962 shows the estimated release to the Columbia River of the radiological risk drivers and Figure 5–963, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For technetium-99, iodine-129, chromium, nitrate, boron, and fluoride, the amount released to the Columbia River is essentially equal to the amount released to groundwater. About 100 percent of the radionuclide amount (curies) and chemical quantity (kilograms) released to groundwater during the period of analysis reaches the river.

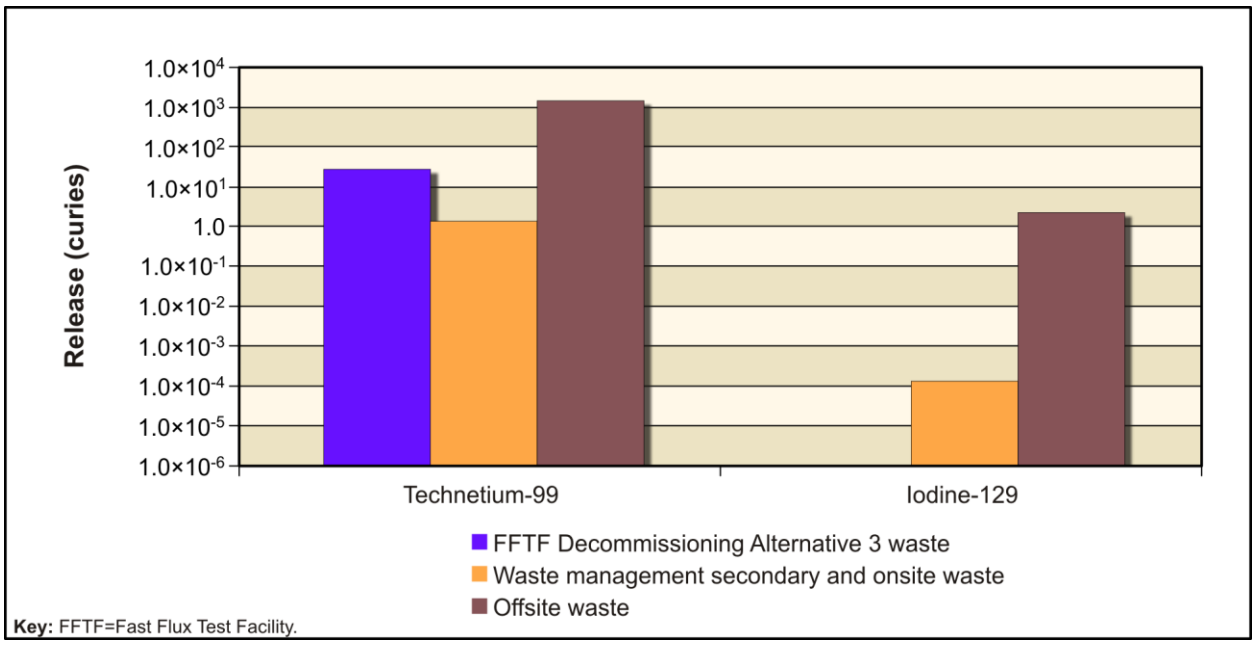


Figure 5–962. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Columbia River

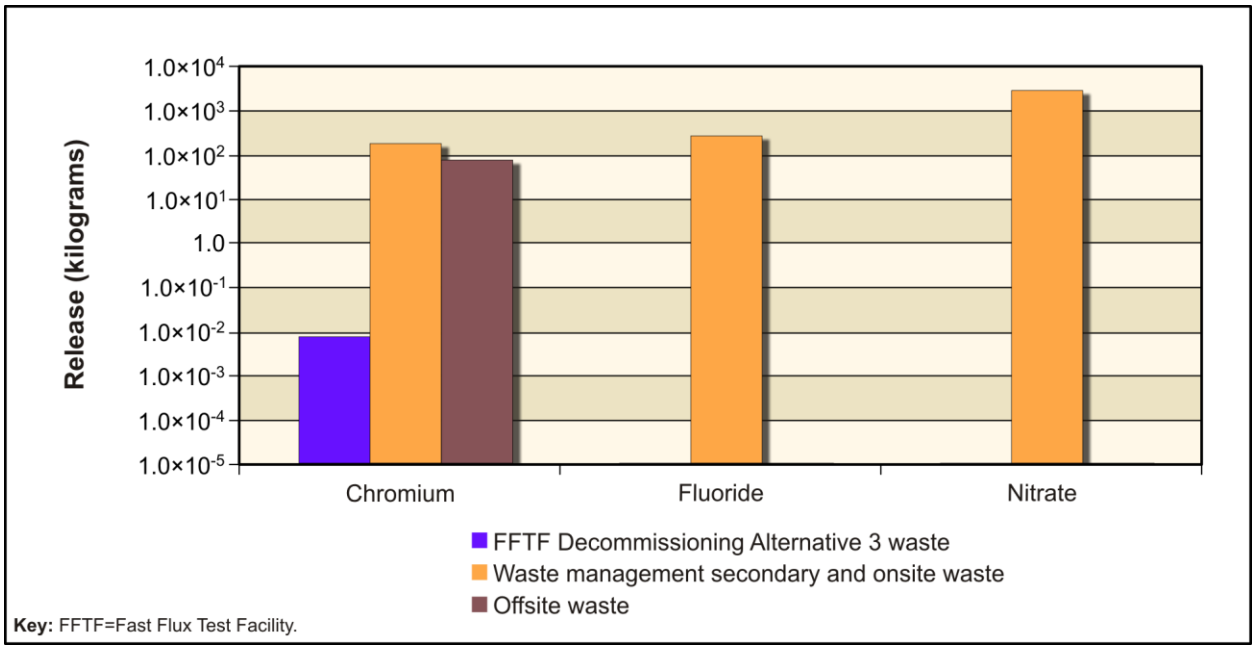


Figure 5–963. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Chemical Releases from 200-West Area Integrated Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the impacts of Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, in terms of groundwater concentration versus time at the Core Zone Boundary and the Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. The benchmark concentration of each radionuclide and chemical is also shown. Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations.

Figures 5–964 through 5–967 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate. Iodine-129 concentrations exceed the benchmark concentration at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore. The greatest exceedance of the benchmark concentration is at the IDF-West barrier, where the benchmark is exceeded by over an order of magnitude from approximately CY 3200 until CY 5000. Iodine-129 concentrations never exceed the benchmark concentration at the IDF-East barrier. The iodine-129 benchmark concentrations are exceeded by less than an order of magnitude at the Core Zone Boundary and Columbia River nearshore. Concentrations of iodine-129 exceed the benchmark concentration at the Columbia River nearshore for the longest period of time and fall below the benchmark in approximately CY 6500. Technetium-99 exhibits behavior similar to iodine-129, where concentrations at the IDF-West barrier exceed the benchmark by one order of magnitude. The duration of the benchmark exceedance is only approximately 1,500 years. In addition, technetium-99 benchmark concentrations are exceeded at the Columbia River nearshore from approximately CY 3500 to CY 5000. Concentrations at the Core Zone Boundary are exceeded from about CY 3500 to CY 4100. Chromium concentrations peak at just under two orders of magnitude below the benchmark. Nitrate does not exceed benchmark concentrations during the period of analysis.

Table 5–113 shows the maximum concentrations of the COPCs in the peak year at IDF-East, IDF-West, the Core Zone Boundary, and Columbia River nearshore. Under Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, iodine-129 and technetium-99 concentrations both exceed their benchmarks at IDF-West, the Core Zone Boundary, and Columbia River nearshore around CY 3900. No other constituents exceed their benchmark concentrations under Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A.

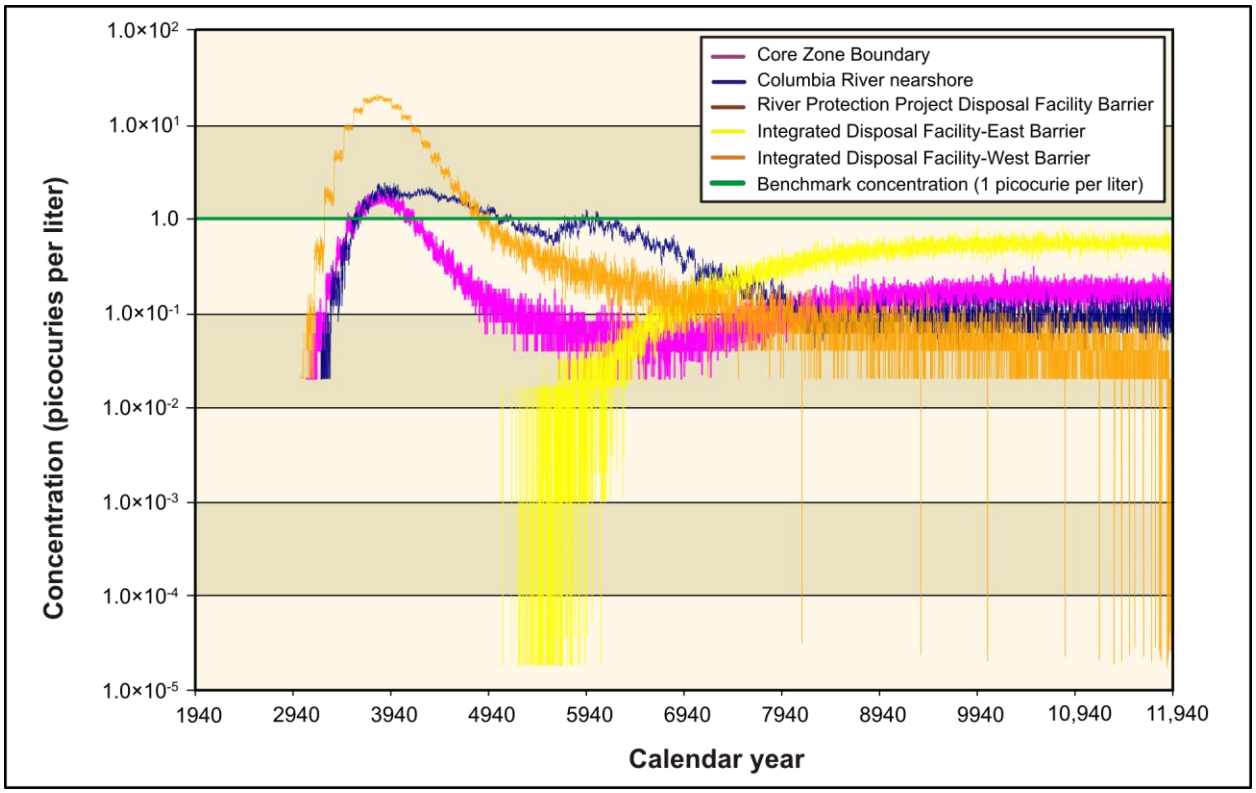


Figure 5–964. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Iodine-129 Concentration Versus Time

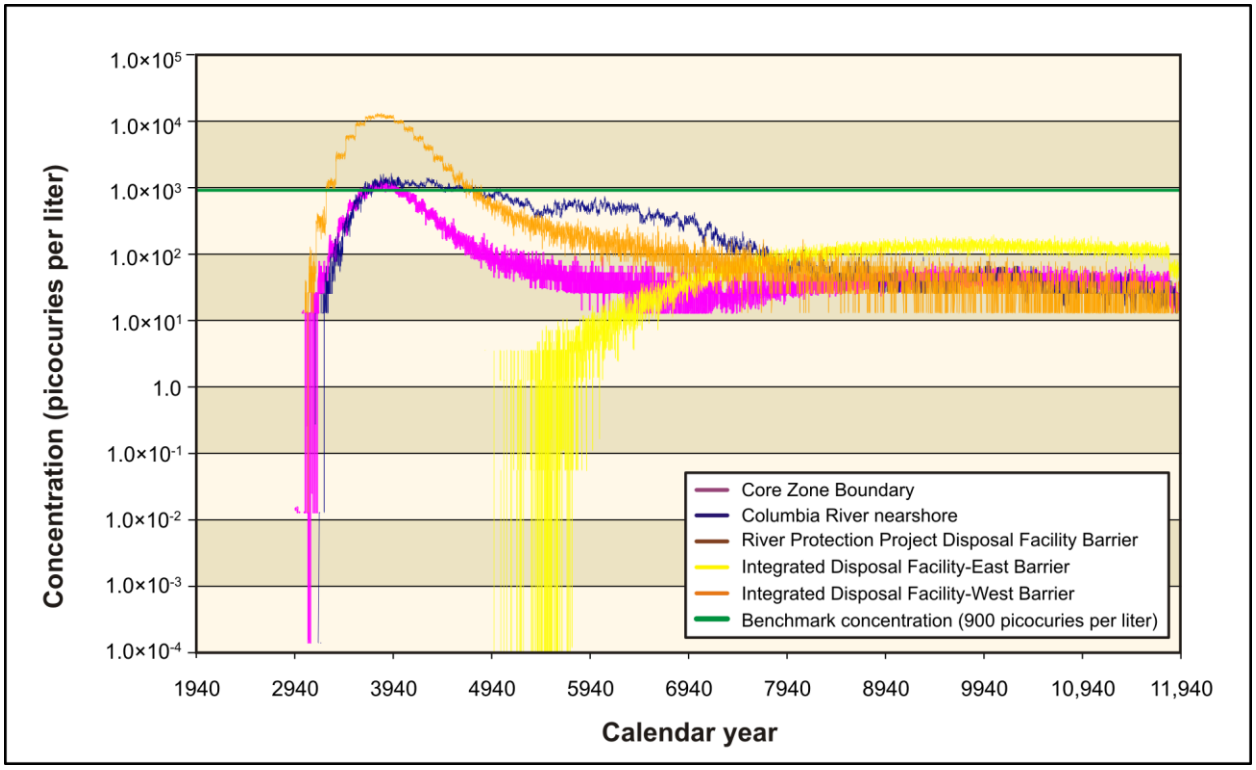


Figure 5–965. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Technetium-99 Concentration Versus Time

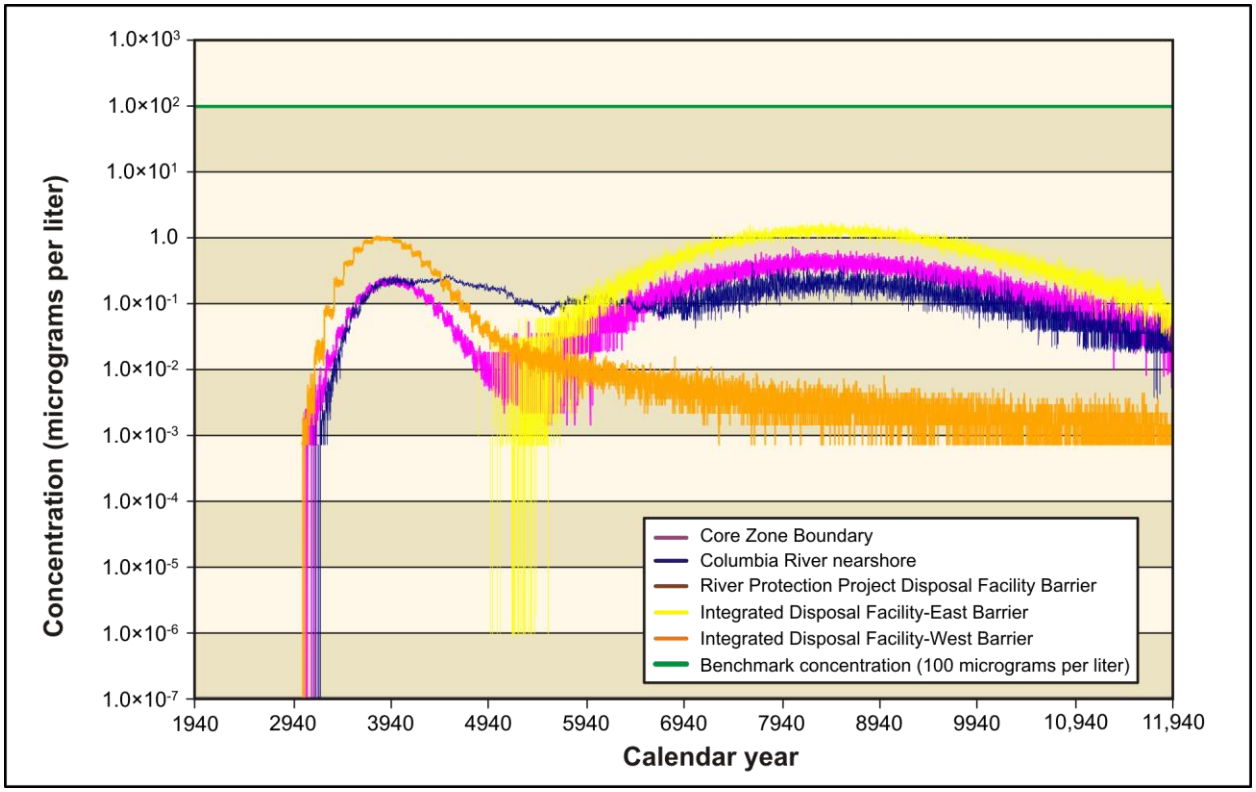


Figure 5–966. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Chromium Concentration Versus Time

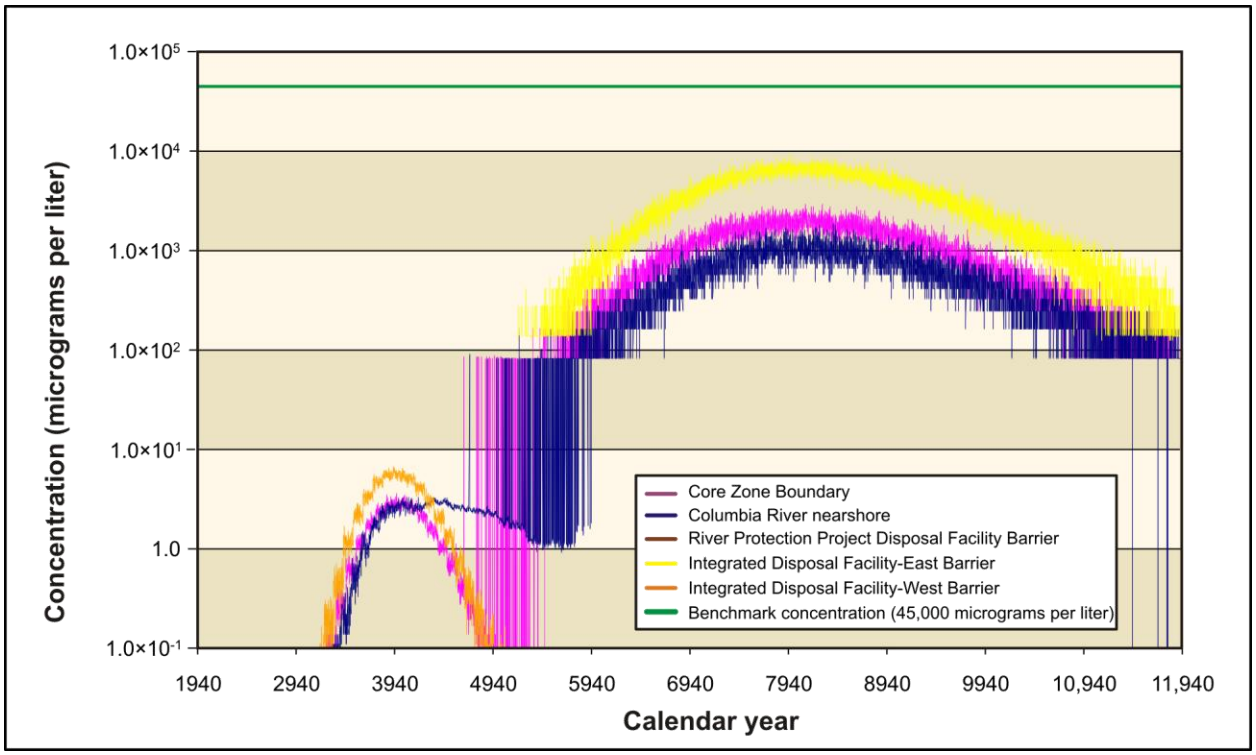


Figure 5–967. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Nitrate Concentration Versus Time

Table 5–113. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Maximum COPC Concentrations in the Peak Year at IDF-East, IDF-West, and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	IDF-West	RPPDF	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	193	**13,200**	N/A	**1,370**	**1,670**	900
	(10,056)	(3818)		(3859)	(3920)	
Iodine-129	0.8	**20.6**	N/A	**2.1**	**2.4**	1
	(9950)	(3794)		(3937)	(3872)	
Chemical (micrograms per liter)						
Chromium	2	1	N/A	1	0	100
	(8791)	(3813)		(8053)	(7640)	
Fluoride	0	1	N/A	0	0	4,000
	(1940)	(4014)		(3937)	(4307)	
Nitrate	9,300	7	N/A	2,920	1,860	45,000
	(7960)	(3927)		(8123)	(8406)	

Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are identified in **bold** text.

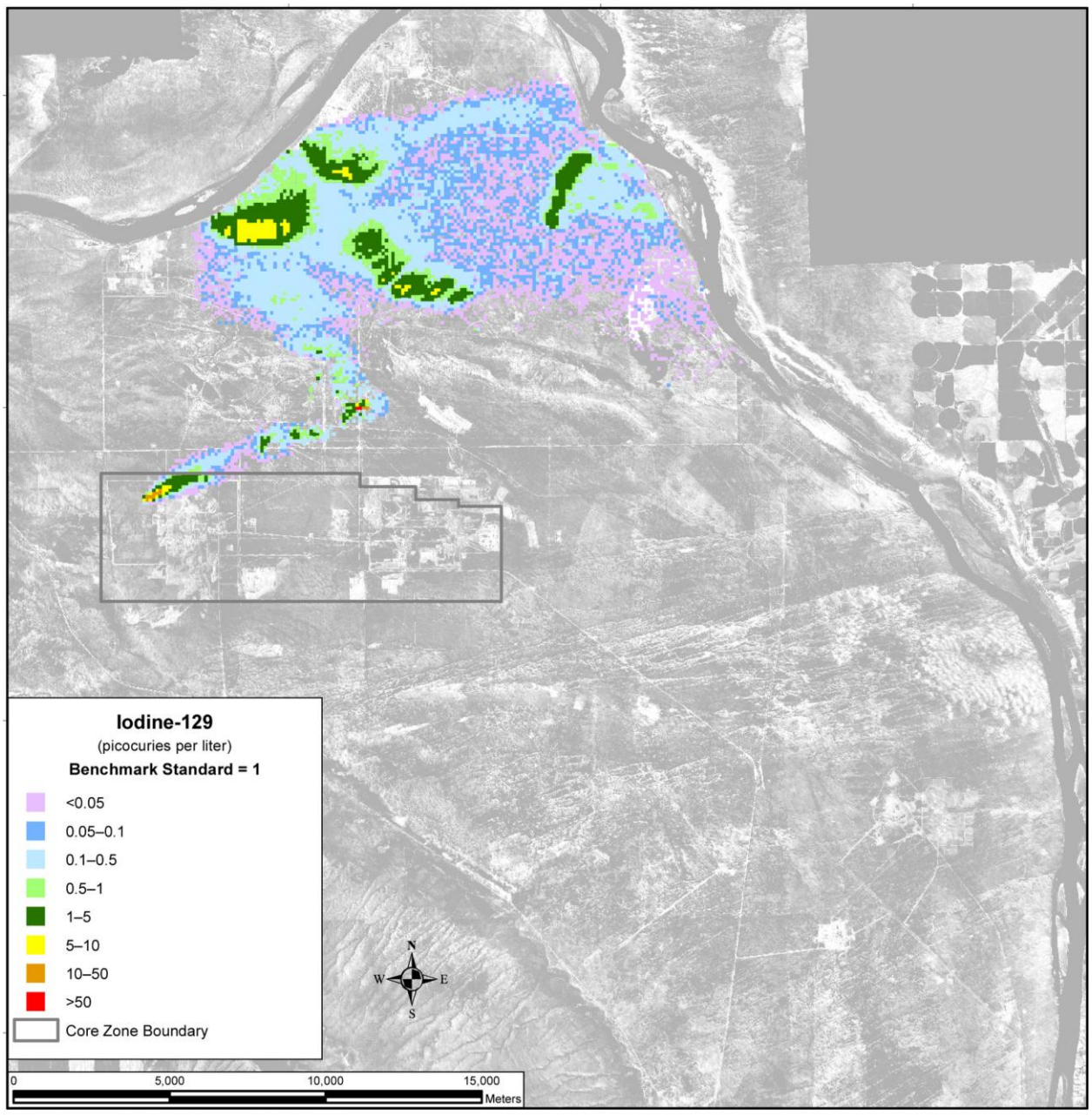
Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; N/A=not applicable; RPPDF=River Protection Project Disposal Facility.

There are no appreciable releases of either uranium-238 or total uranium to the environment over the analysis period under Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A.

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

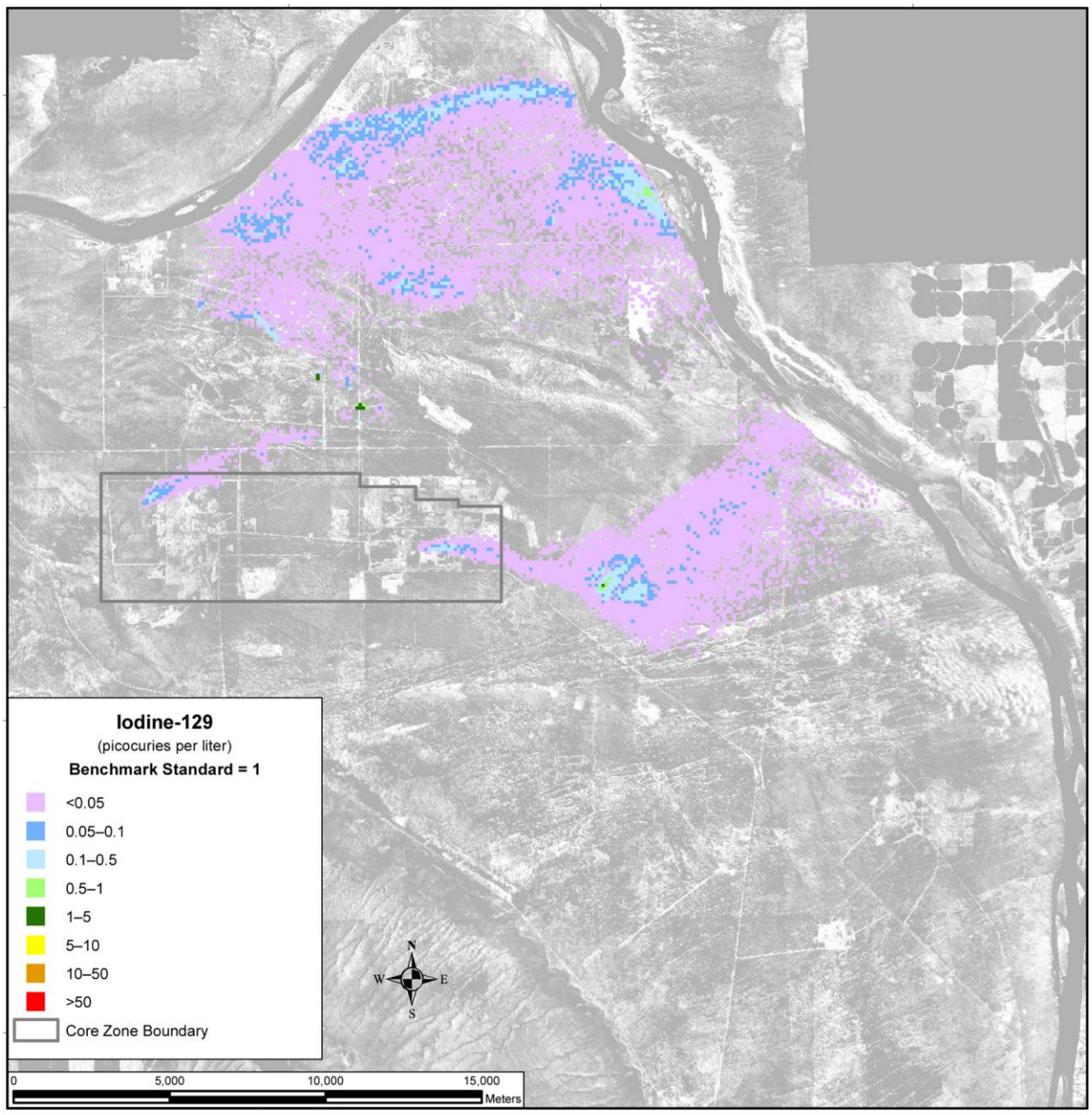
This section presents the impacts of Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated by the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations.

Figure 5–968 shows the spatial distribution of iodine-129 concentrations in groundwater in CY 3890. Releases from IDF-West result in a groundwater plume starting in the Core Zone and heading north through Gable Gap. This plume exceeds the benchmark concentration at the Core Zone Boundary and north of the Core Zone Boundary by as much as 10 to 50 times. In CY 7140, releases from IDF-East create a groundwater plume, not exceeding the benchmark, that extends from the 200-East Area east toward the Columbia River (see Figure 5–969). Also by CY 7140, most of the IDF-West plume continues to move north and reaches the Columbia River. By CY 11,885, most of the mass in the IDF-East plume is still moving east toward the Columbia River, with peak concentrations exceeding the benchmark by up to 5 times (see Figure 5–970). Technetium-99 (see Figures 5–971 through 5–973) shows similar spatial distributions at selected times and exceeds its benchmark concentration at approximately the same time and locations. Chromium (see Figures 5–974 through 5–976) and nitrate (see Figures 5–977 through 5–979) show similar spatial distributions at selected times, but neither exceeds its benchmark concentration. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., they move at the pore-water velocity).



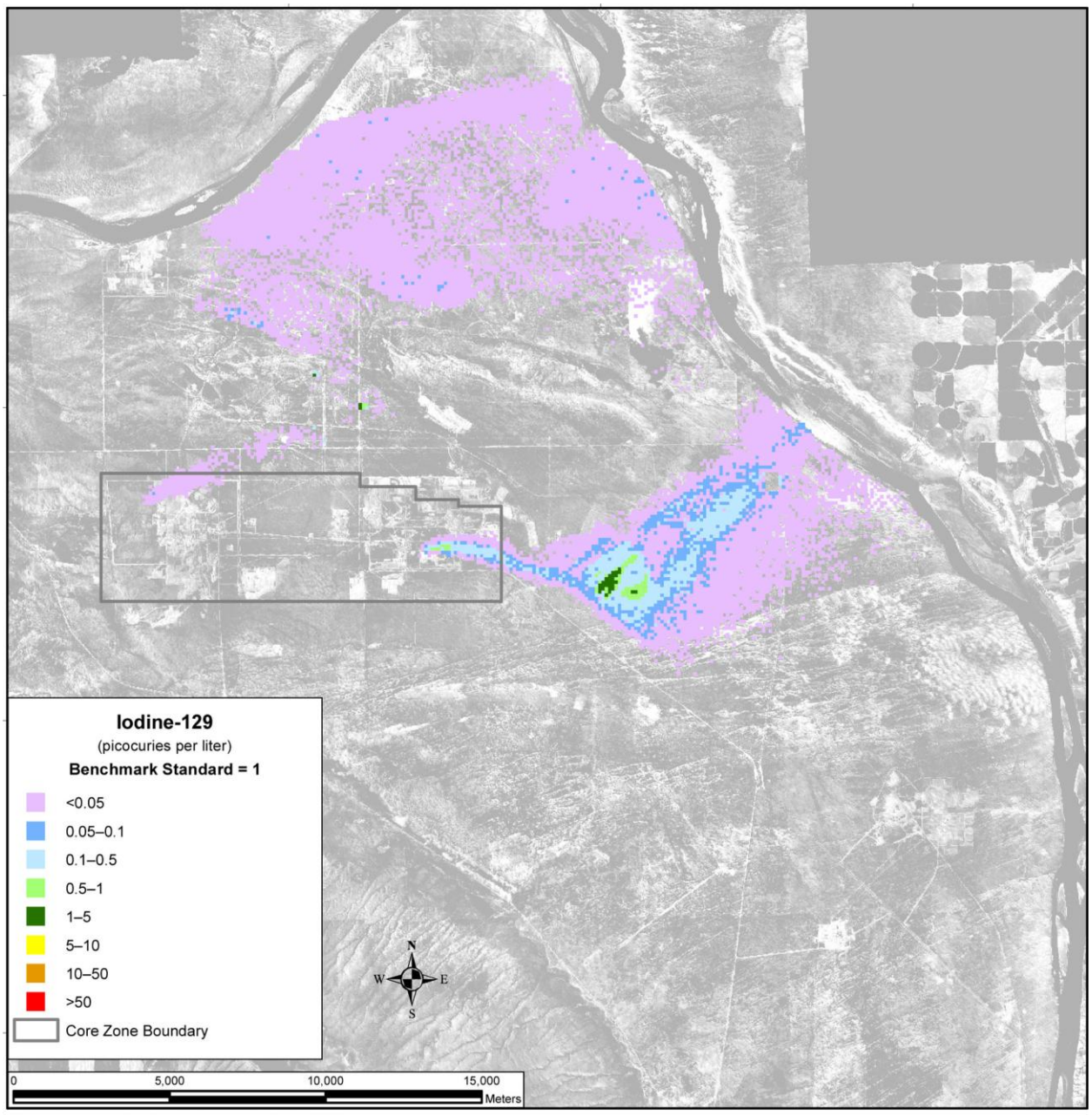
Note: To convert meters to feet, multiply by 3.281.

Figure 5–968. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



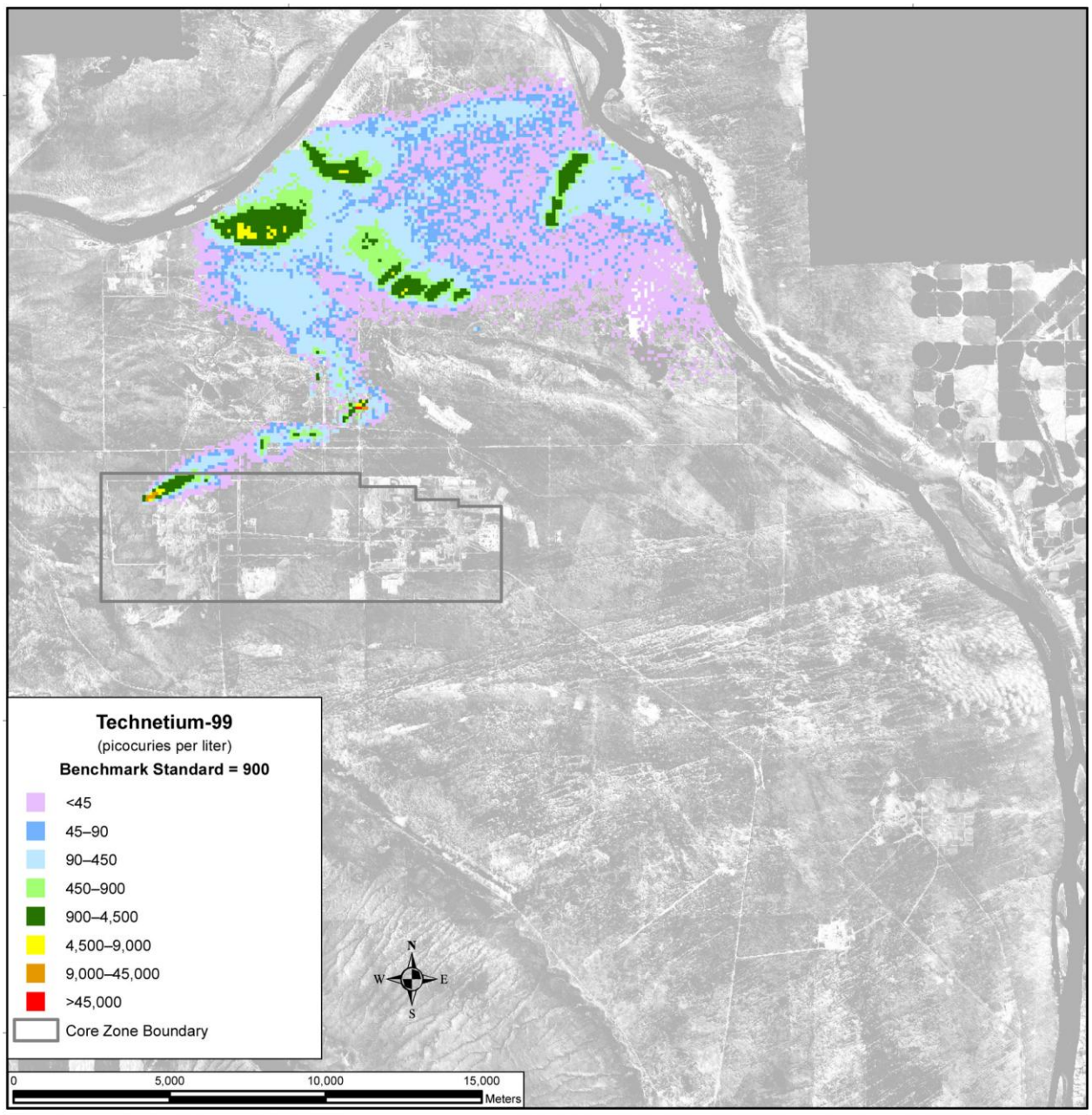
Note: To convert meters to feet, multiply by 3.281.

Figure 5–969. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



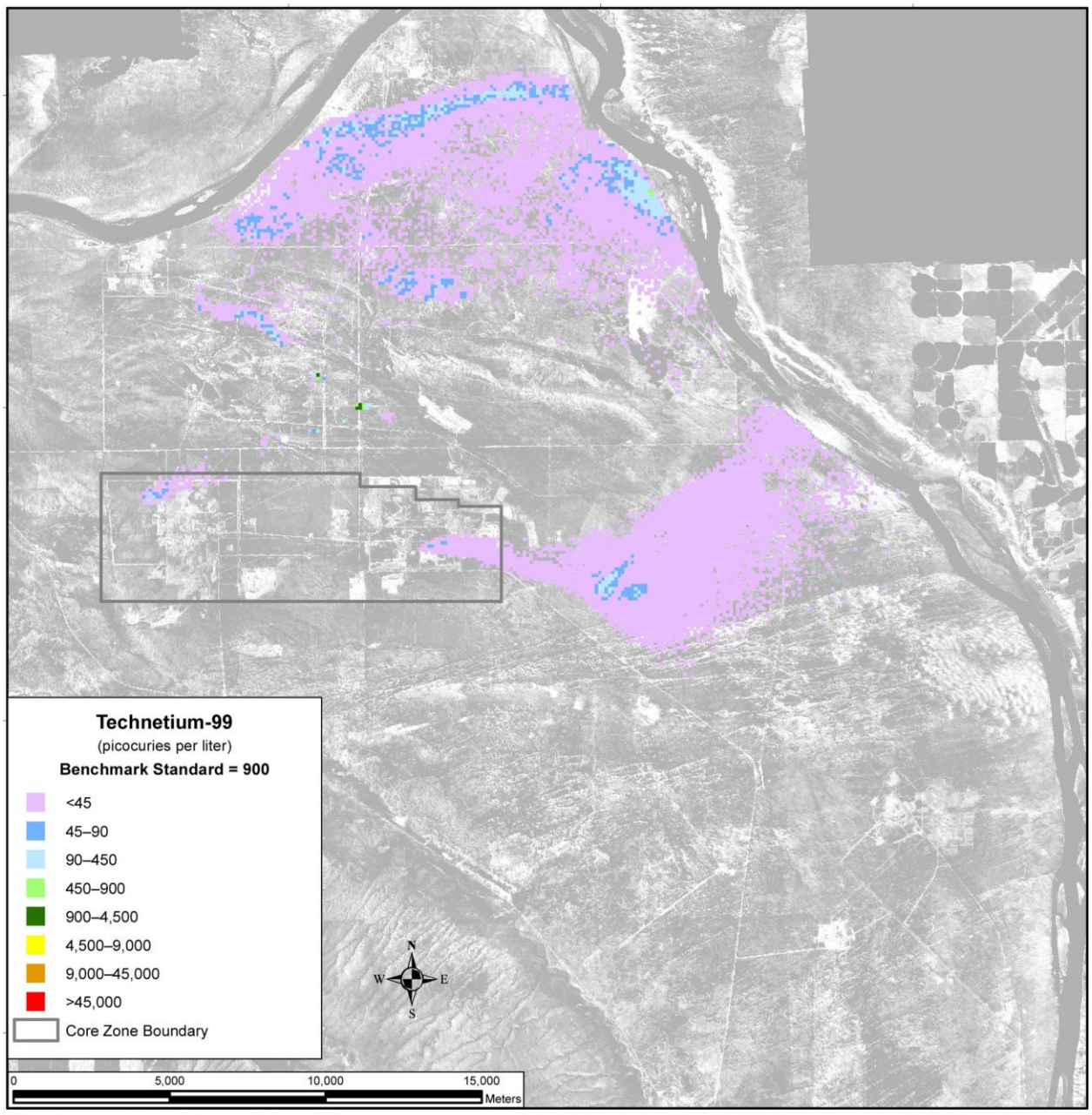
Note: To convert meters to feet, multiply by 3.281.

Figure 5–970. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



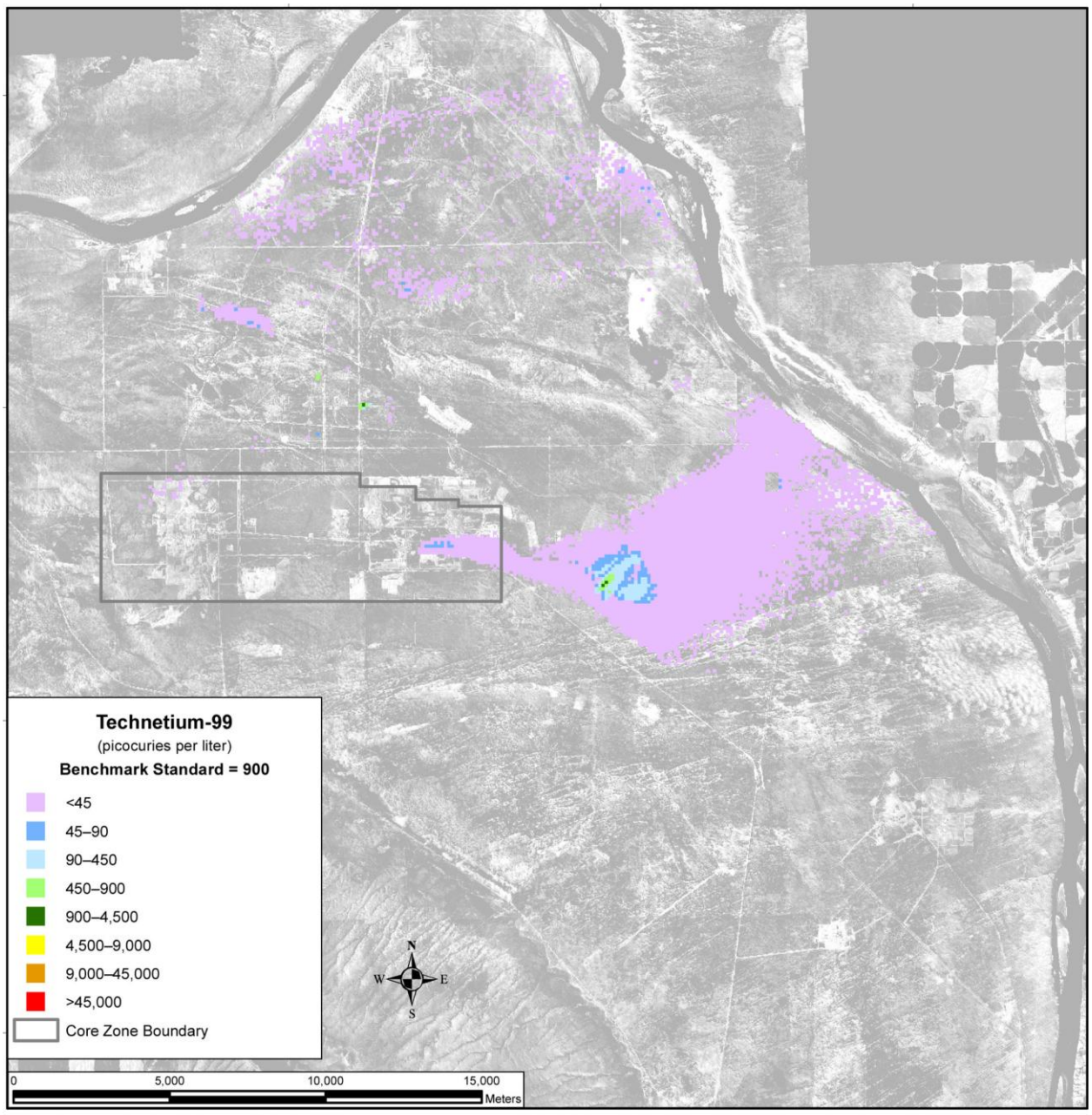
Note: To convert meters to feet, multiply by 3.281.

Figure 5–971. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



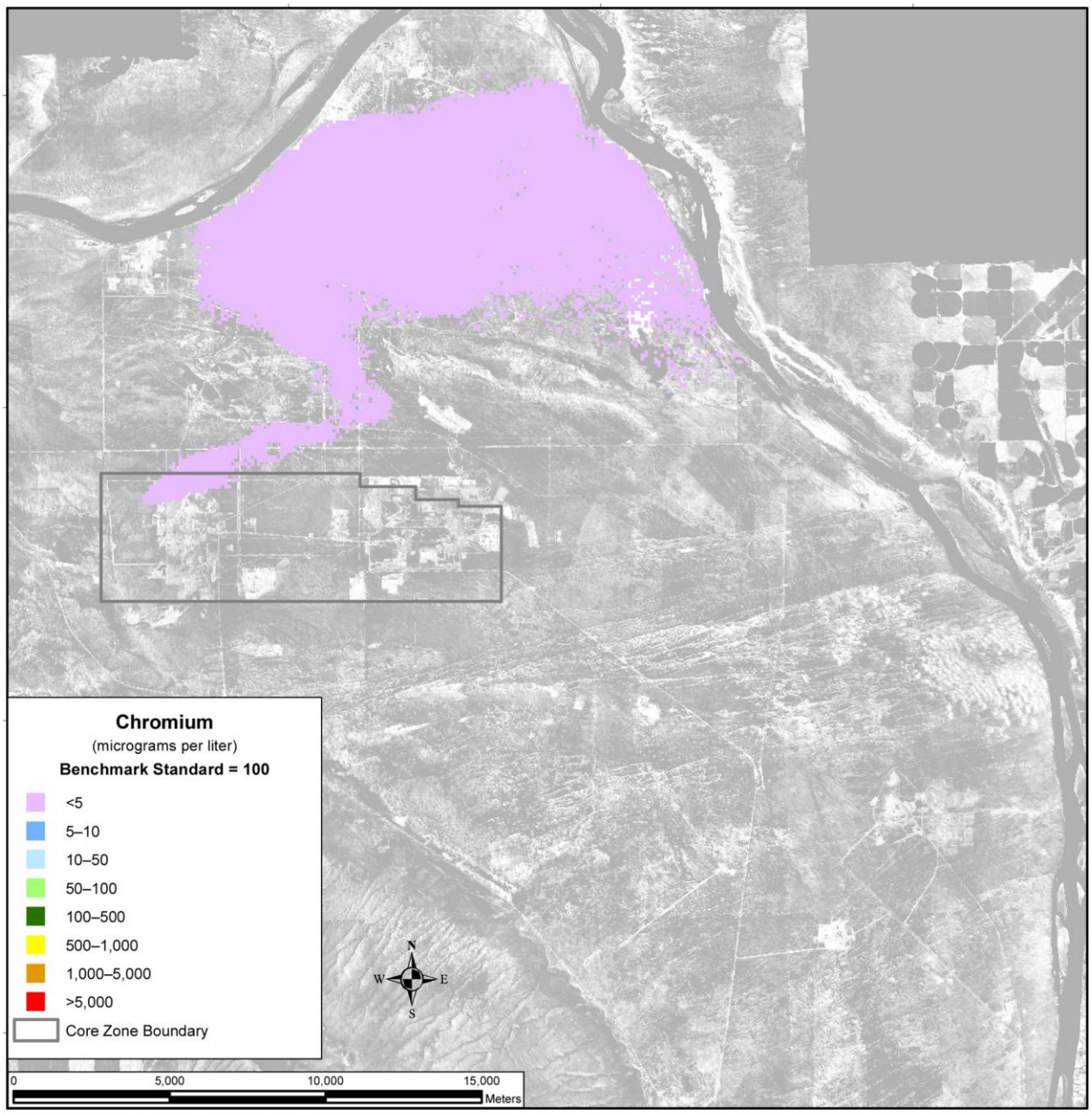
Note: To convert meters to feet, multiply by 3.281.

Figure 5–972. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140



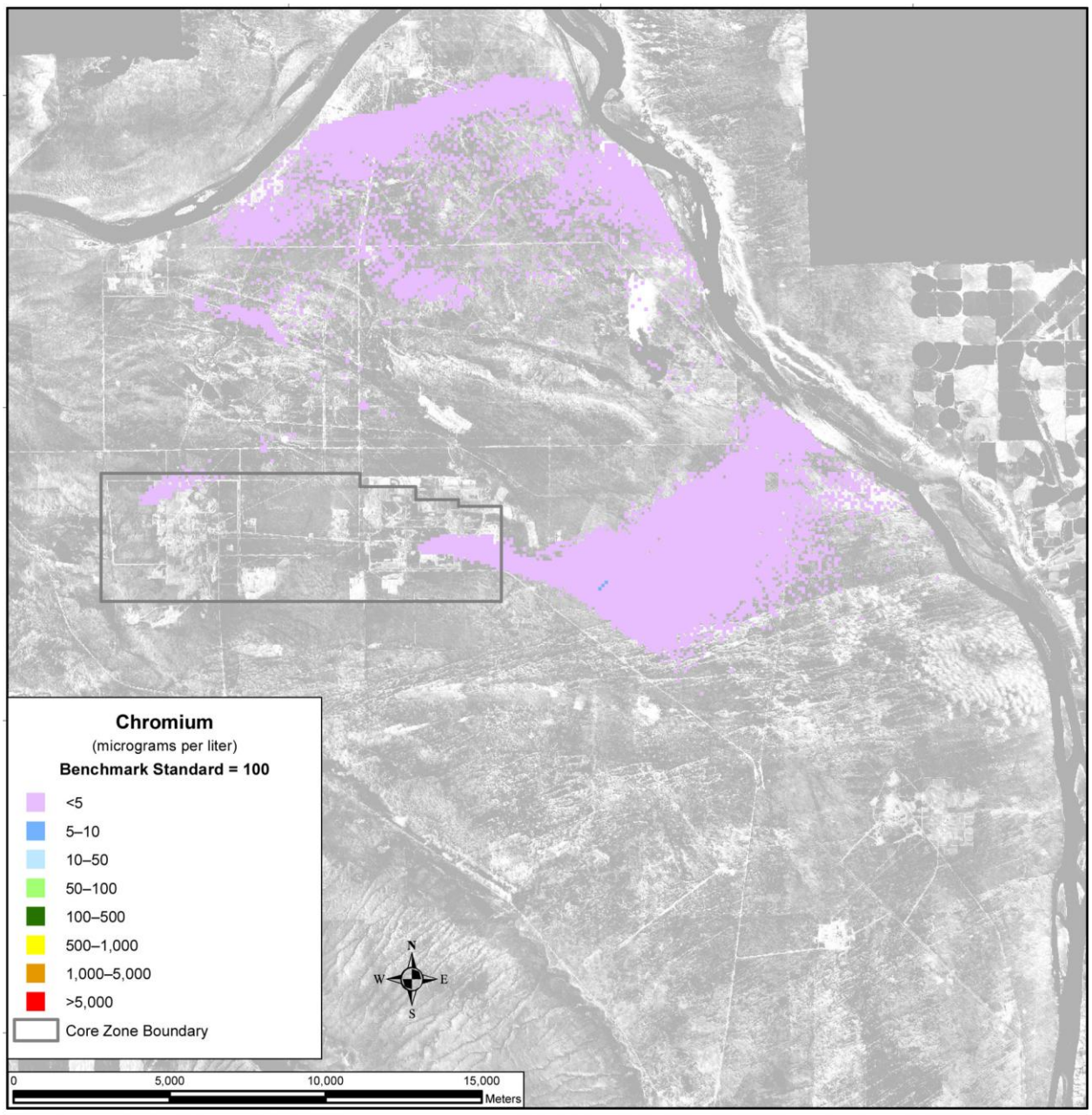
Note: To convert meters to feet, multiply by 3.281.

Figure 5–973. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 11,885



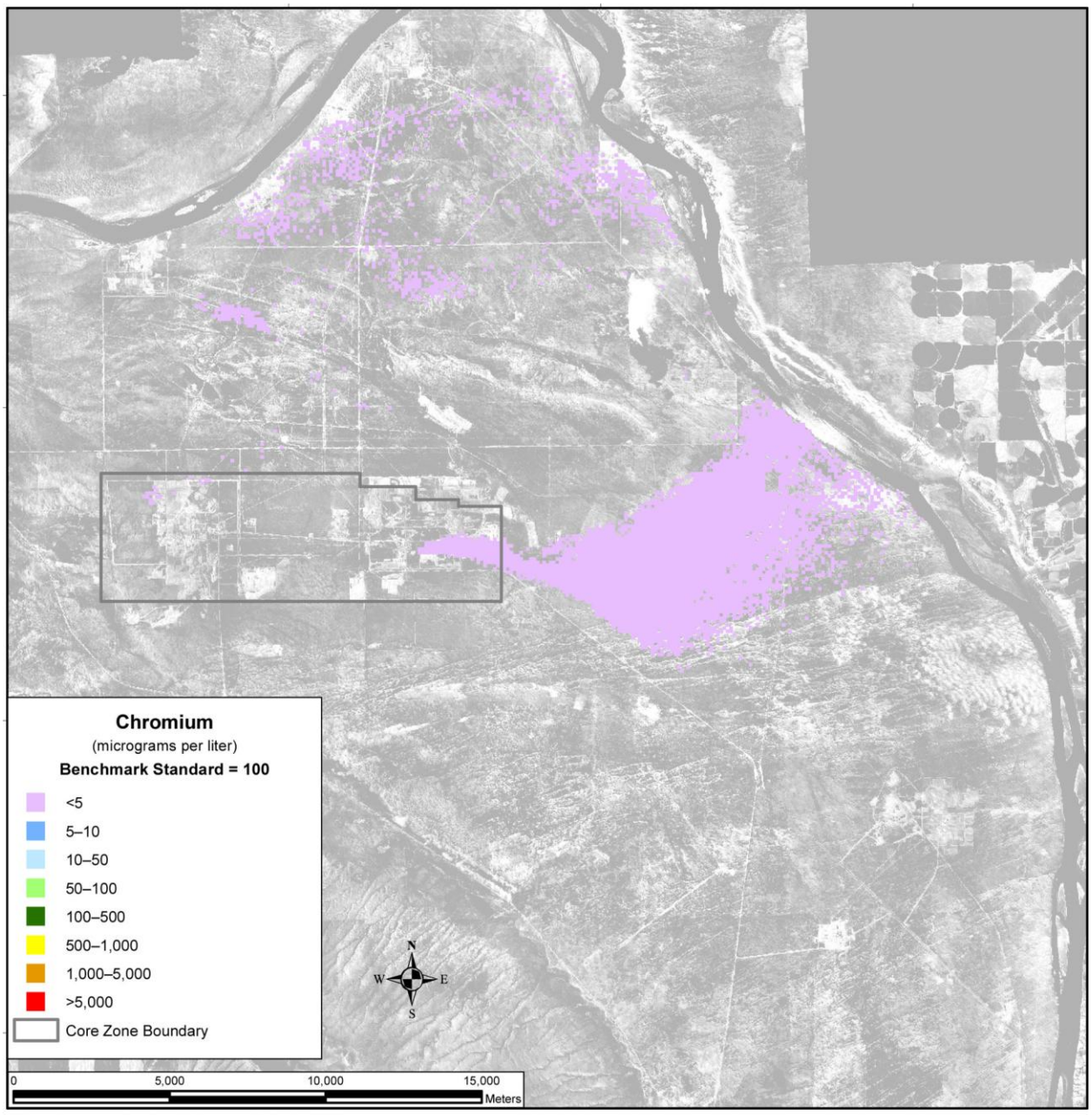
Note: To convert meters to feet, multiply by 3.281.

Figure 5–974. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 3890



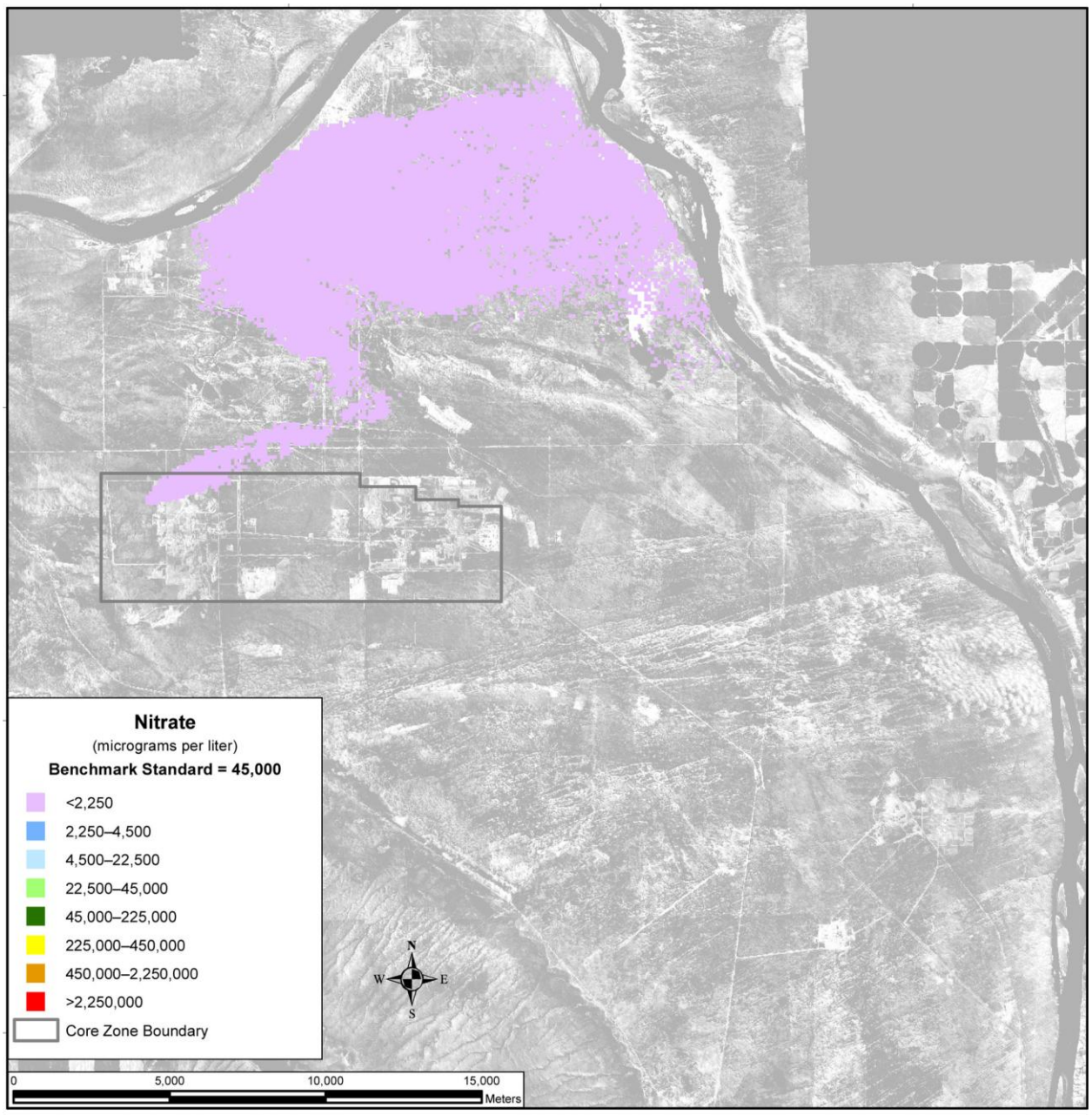
Note: To convert meters to feet, multiply by 3.281.

Figure 5–975. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 7140



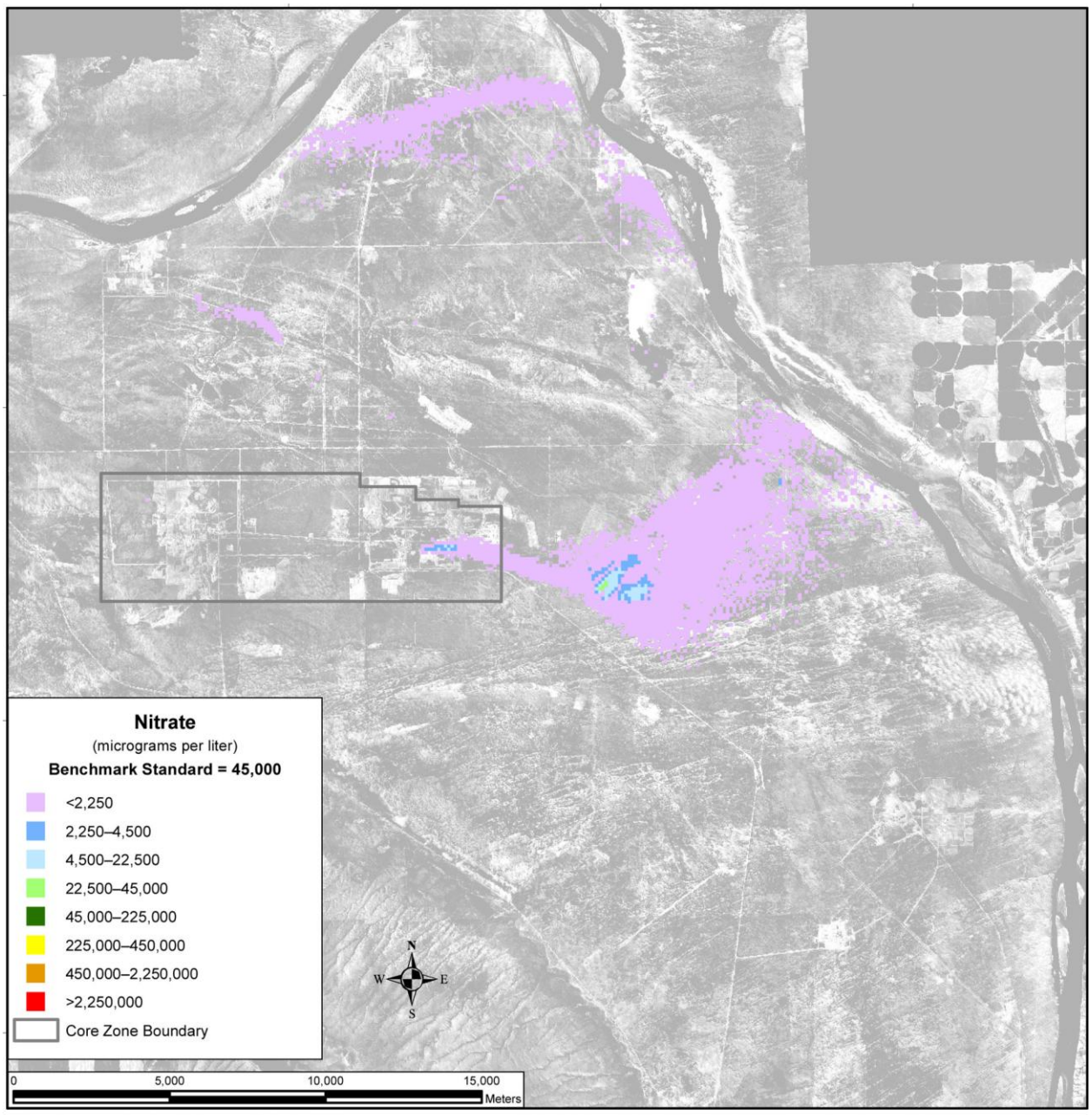
Note: To convert meters to feet, multiply by 3.281.

Figure 5–976. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Chromium Concentration, Calendar Year 11,885



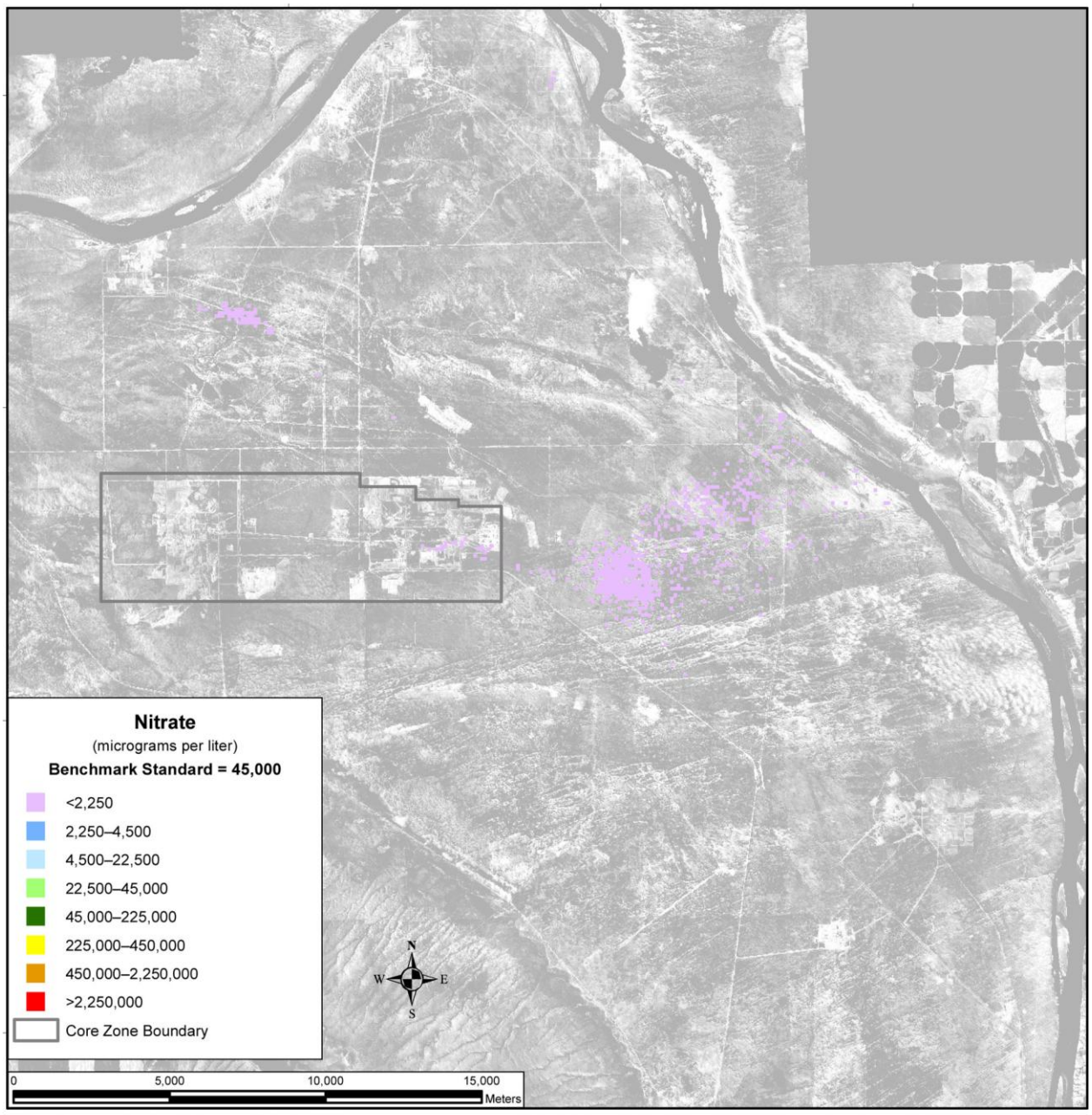
Note: To convert meters to feet, multiply by 3.281.

Figure 5–977. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

Figure 5–978. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 7140



Note: To convert meters to feet, multiply by 3.281.

Figure 5–979. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, Spatial Distribution of Groundwater Nitrate Concentration, Calendar Year 11,885

There are no appreciable releases of either uranium-238 or total uranium to the environment over the analysis period under Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A.

SUMMARY OF IMPACTS

Under Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A, in general, the inventories remaining in IDF-East and IDF-West, which are available for release to the environment at the start of the post-disposal period, are predominant contributors.

For the conservative tracers, only concentrations of technetium-99 and iodine-129 exceed their benchmarks at the IDF-West barrier, the Core Zone Boundary, and Columbia River nearshore. Both

constituents exceed the benchmark standards by over one order of magnitude at the IDF-West barrier and by less than one order of magnitude at the Core Zone Boundary and Columbia River nearshore around CY 3900.

There are no appreciable releases of either uranium-238 or total uranium to the environment over the analysis period under Waste Management Alternative 3, Disposal Group 2, Subgroup 2-A.

5.3.1.3.2.2 Disposal Group 2, Subgroup 2-B, Base Case

Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, was designed to show the impacts of waste disposal on IDF-East, IDF-West, and the RPPDF.

ACTIONS AND TIMEFRAMES INFLUENCING GROUNDWATER IMPACTS

Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, was designed to accommodate the disposal of wastes generated under Tank Closure Alternative 6B and FFTF Decommissioning Alternative 2 or 3, as well as onsite and offsite waste.

For the long-term groundwater impacts analysis, two major periods have been identified for Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, as follows:

- The disposal period was assumed to start with the onset of disposal operations in IDF-East and IDF-West in CY 2009 and in the RPPDF in CY 2022 and continue through CY 2100 for IDF-East and the RPPDF and through CY 2050 for IDF-West, when these disposal facilities would be operationally closed. During the disposal period, the materials in these permitted, operational facilities would not be available for release to the environment.

- The post-disposal period was assumed to start in CY 2101 and continue through the 10,000-year period of analysis until CY 11,940. At the start of this period, materials in IDF-East and IDF-West would become available for release to the environment, and it was assumed for analysis purposes that barriers would be emplaced over the facilities to limit infiltration during the first 500 years of the post-disposal period.

COPC DRIVERS

A total of 40 COPCs were analyzed for Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case. Complete results are tabulated in Appendices M, N, and O, but this discussion of long-term impacts associated with Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case (i.e., Tank Closure Alternative 6B, Base Case; FFTF Decommissioning Alternative 2 or 3; and onsite and offsite waste), is focused on the following COPC drivers:

- Radiological risk drivers: iodine-129 and technetium-99
- Chemical risk drivers: none
- Chemical hazard drivers: chromium, fluoride, and nitrate

The COPC drivers for Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, were selected by evaluating the risk or hazard associated with all 40 COPCs during the year of peak risk or hazard at the Core Zone Boundary during the 10,000-year period of analysis and selecting the major contributors. This process is described in Appendix Q. The radiological risk drivers listed above account for essentially 100 percent of the radiological risk. No chemical risk is predicted. The chemical hazard drivers above account for over 99 percent of the chemical hazard associated with Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B.

The COPC drivers that are discussed in detail in this section (iodine-129, technetium-99, fluoride, chromium, and nitrate) are all mobile (i.e., they move with groundwater) and long-lived (relative to the 10,000-year period of analysis), or stable. They are essentially conservative tracers. The other COPCs that were analyzed do not significantly contribute to drinking water risk at the Core Zone Boundary during the period of analysis because of high retardation factors (i.e., retention in the vadose zone), short half-lives (i.e., rapid radioactive decay), or a combination of both factors.

ANALYSIS OF RELEASE AND MASS BALANCE

This section presents the impacts of Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, in terms of the total amount of COPCs released from IDF-East, IDF-West, and the RPPDF to the vadose zone, groundwater, and the Columbia River during the 10,000-year period of analysis. Releases of radionuclides are totaled in curies; chemicals, in kilograms. Subtotals are plotted in Figures 5–980 through 5–997, representing releases from the three disposal facilities: PPF glass, ETF-generated secondary waste, retired melters, and tank closure secondary waste released from IDF-East; FFTF Decommissioning Alternative 3 waste, waste management secondary and onsite waste, and offsite waste released from IDF-West; and waste released from the RPPDF. Note that the release amounts are plotted on a logarithmic scale to facilitate visual comparison of releases that vary over more than 10 orders of magnitude within the same series of figures.

200-East Area Integrated Disposal Facility

Figure 5–980 shows the estimated release from IDF-East to the vadose zone of the radiological risk drivers and Figure 5–981, the chemical hazard drivers. For technetium-99, chromium, and nitrate, the release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). For the radioactive COPCs (technetium-99 and iodine-129), the releases range over five orders of magnitude, depending on the source of both radionuclides. ETF-generated secondary waste and tank closure secondary waste account for most of the releases. The entire release of nitrate from IDF-East is associated with ETF-generated secondary waste. Sources of chromium include tank closure secondary waste, PPF glass, retired melters, and ETF-generated secondary waste.

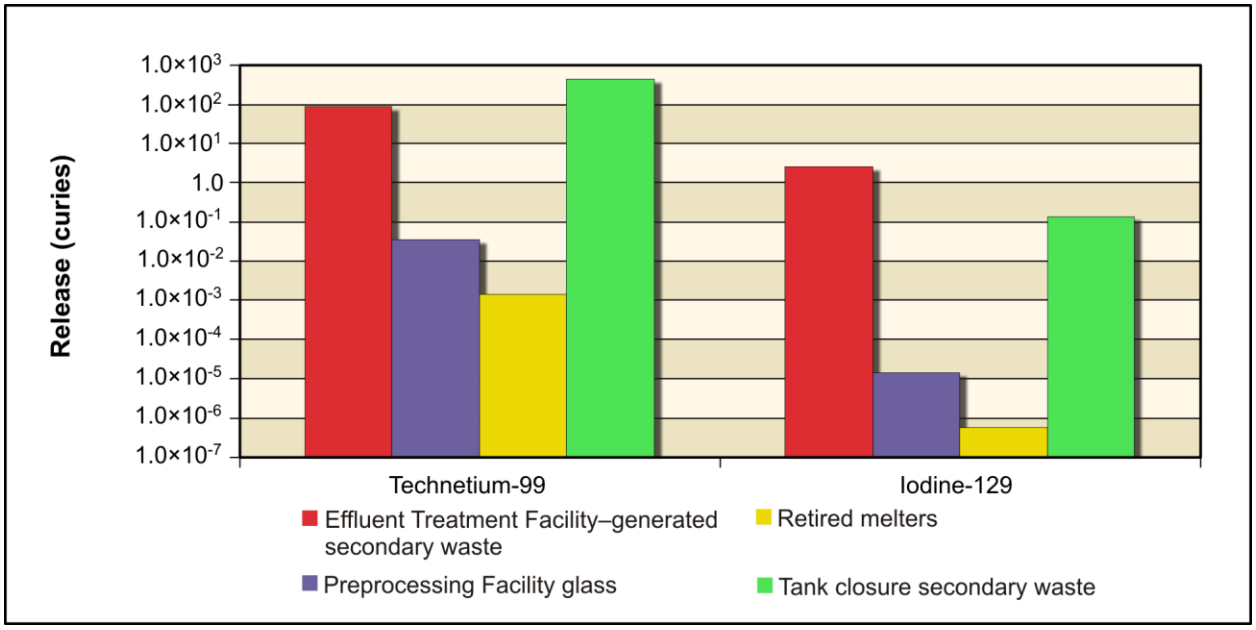


Figure 5–980. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

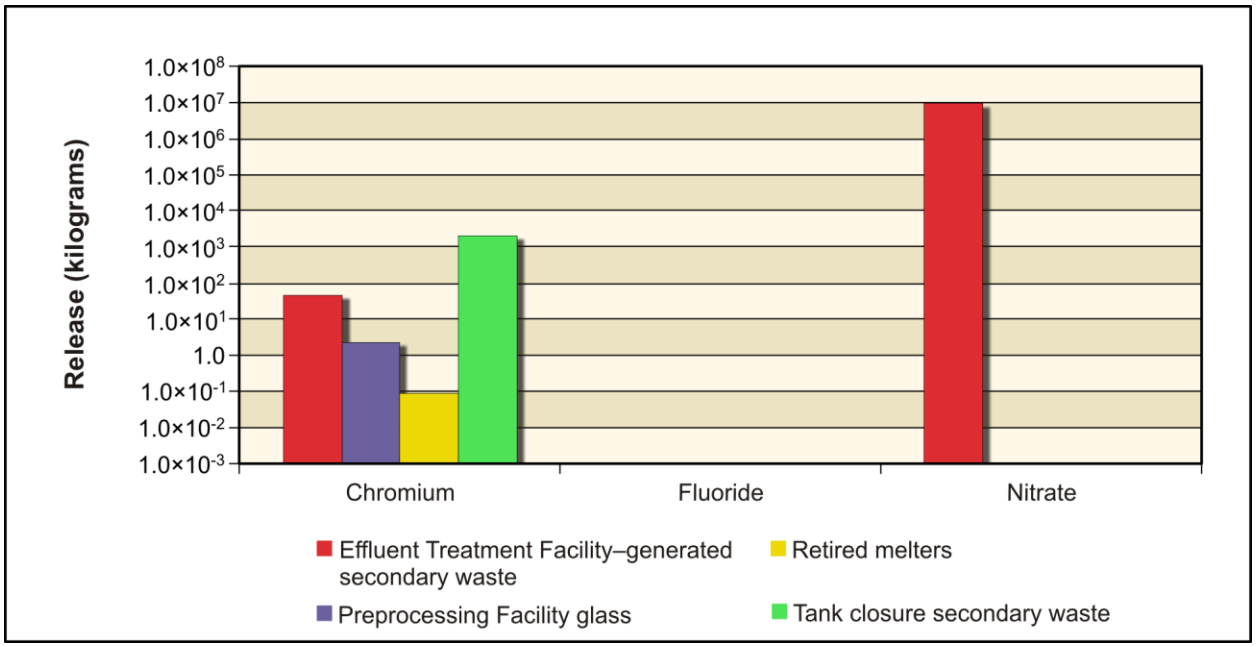


Figure 5–981. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Vadose Zone

Figure 5–982 shows the estimated release from IDF-East to groundwater of the radiological risk drivers and Figure 5–983, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For the conservative tracers iodine-129 and technetium-99, the amount released to groundwater is approximately 42 and 58 percent, respectively. For chromium and nitrate, the amount released to groundwater is essentially equal to the amount released to the vadose zone.

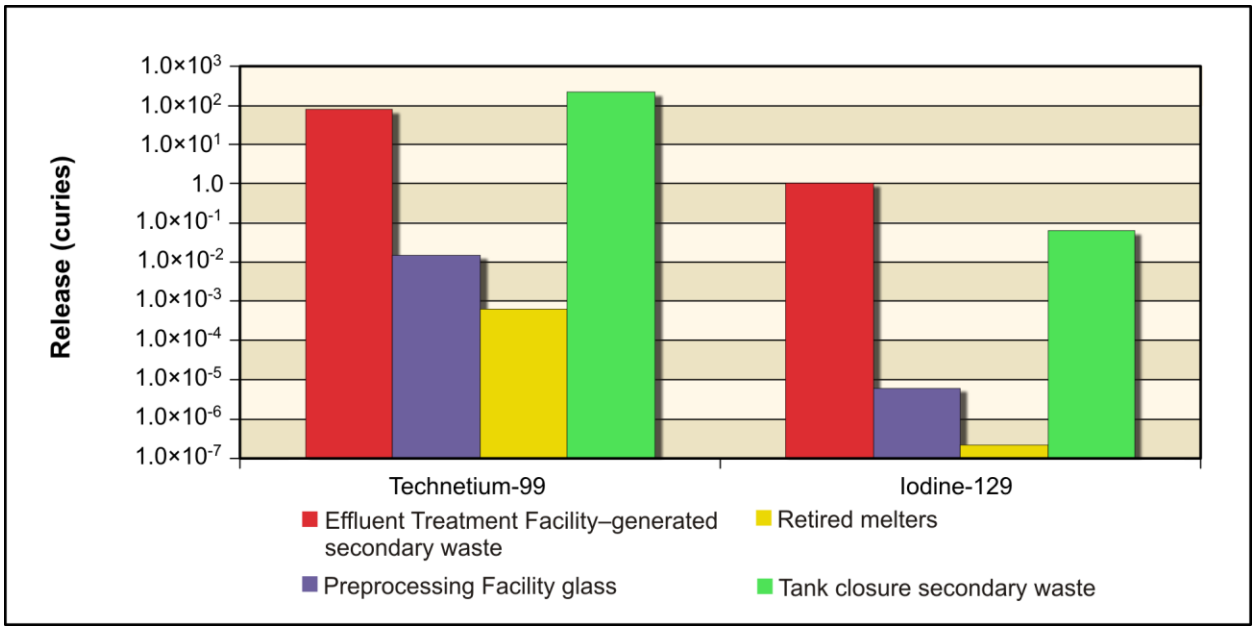


Figure 5–982. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Groundwater

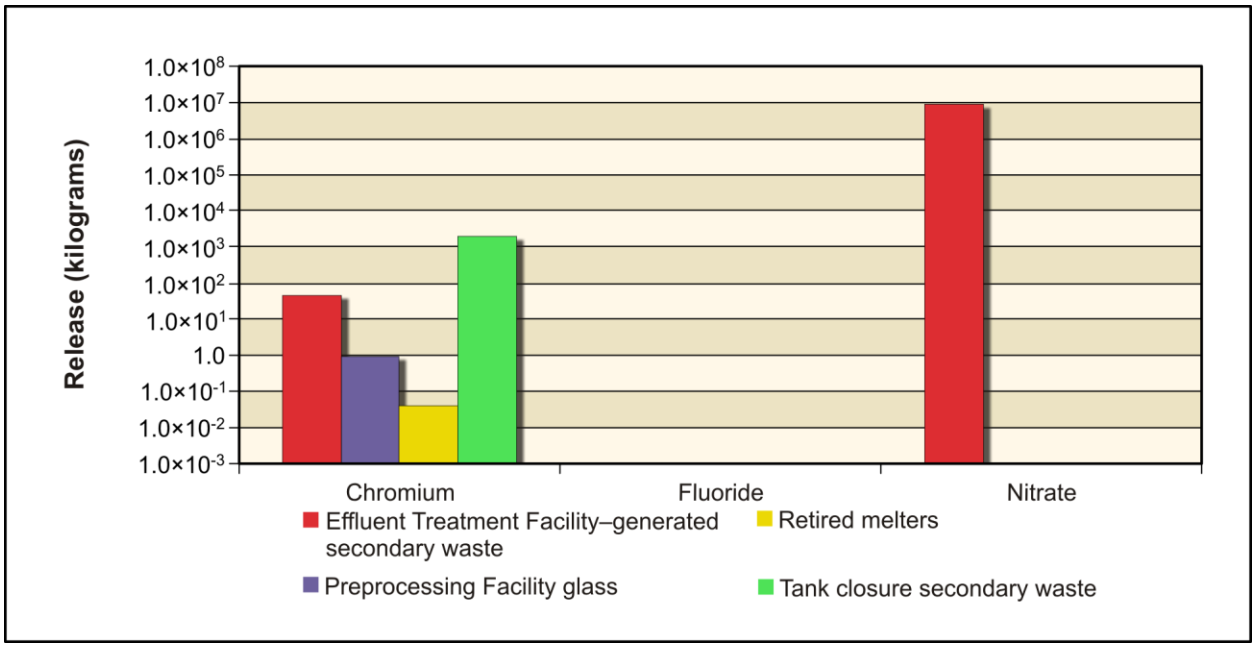


Figure 5–983. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Groundwater

Figure 5–984 shows the estimated release from IDF-East to the Columbia River of the radiological risk drivers and Figure 5–985, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For the conservative tracers (iodine-129, technetium-99, chromium, and nitrate), the amount released to the Columbia River is essentially equal to the amount released to groundwater.

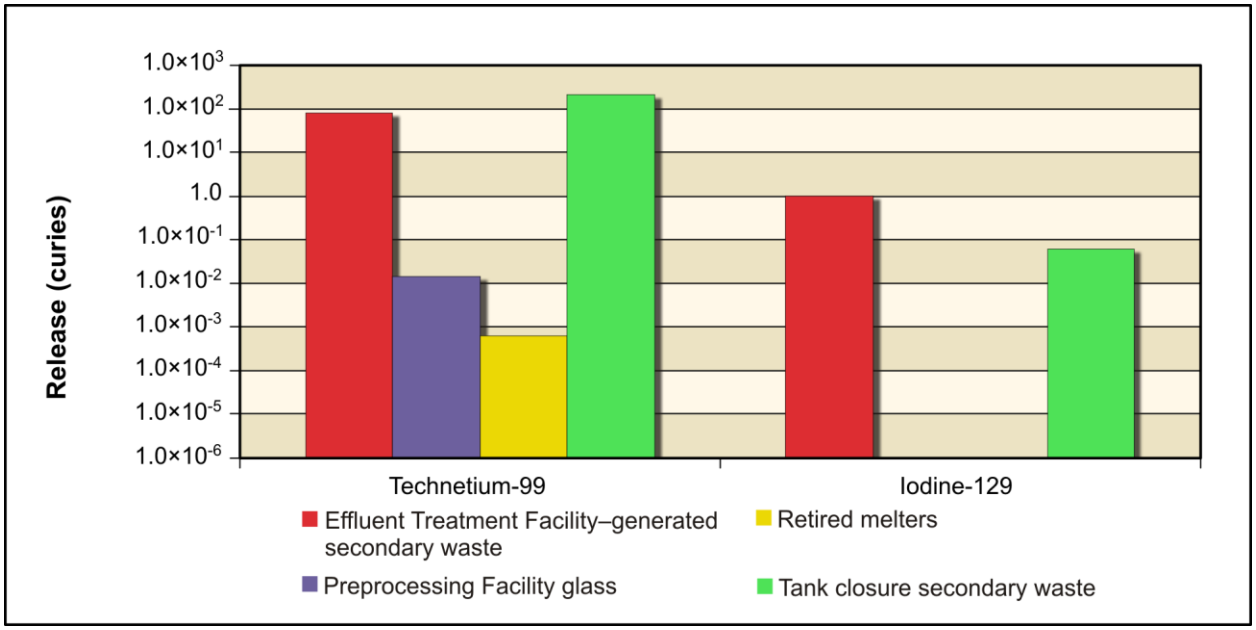


Figure 5–984. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from 200-East Area Integrated Disposal Facility to Columbia River

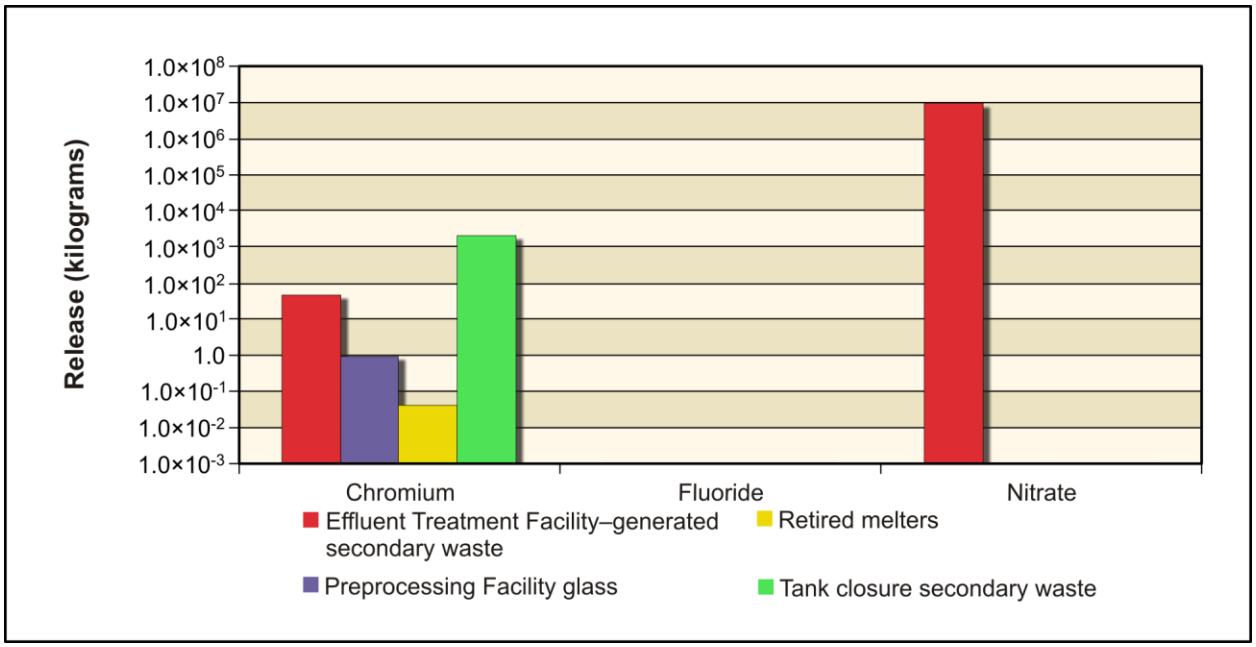


Figure 5–985. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from 200-East Area Integrated Disposal Facility to Columbia River

200-West Area Integrated Disposal Facility

Figure 5–986 shows the estimated release from IDF-West to the vadose zone of the radiological risk drivers and Figure 5–987, the chemical hazard drivers. For offsite waste, the release to the vadose zone is controlled by the inventory (i.e., 100 percent of the inventory is released during the post-disposal period). For the radioactive COPCs (technetium-99 and iodine-129) in IDF-West, the releases range over five orders of magnitude, depending on the source. Over 99 percent of the radioactive waste is from offsite waste. The chromium in IDF-West and essentially all of the nitrate and fluoride derive from releases associated with waste management secondary and onsite waste. Of the chromium sources, less than 1 percent is from FFTF Decommissioning Alternative 3 waste, 69 percent is from waste management secondary and onsite waste, and 31 percent is from offsite waste.

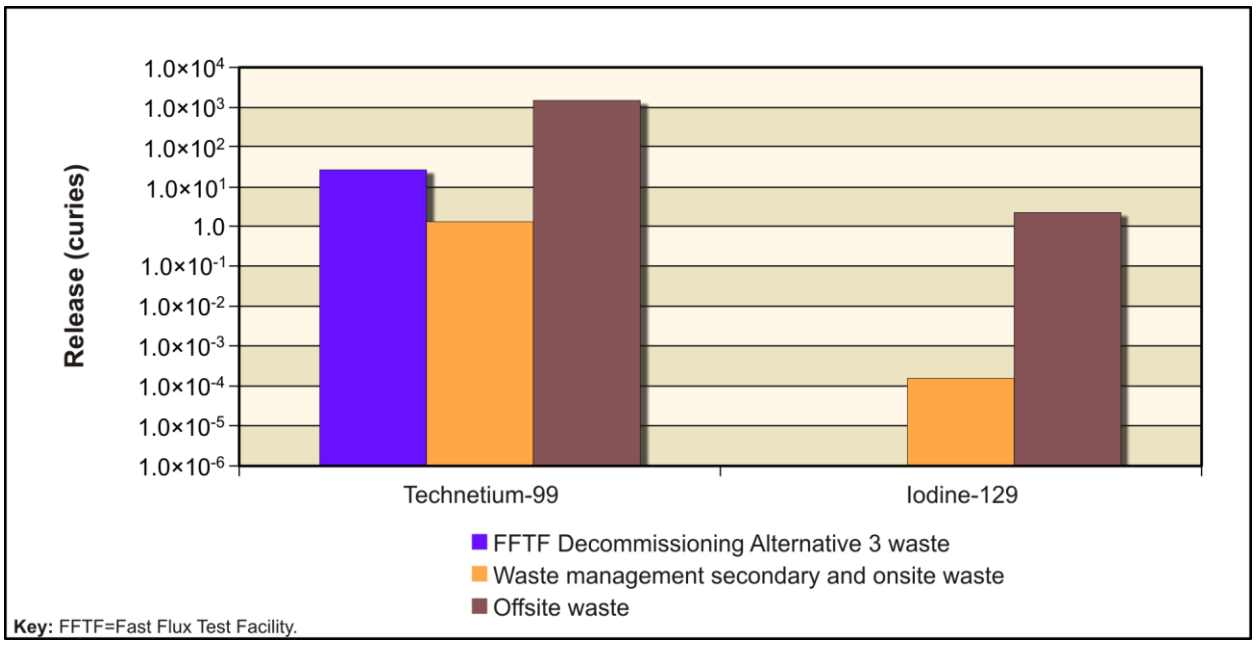


Figure 5–986. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

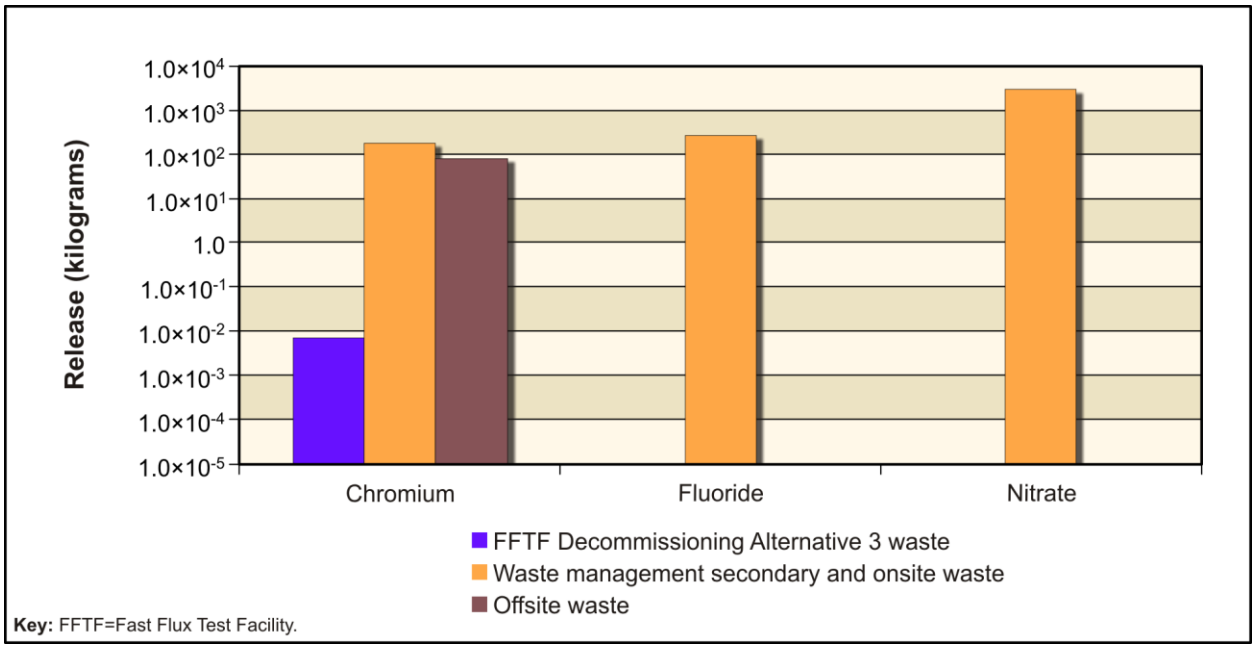


Figure 5–987. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from 200-West Area Integrated Disposal Facility to Vadose Zone

Figure 5–988 shows the estimated release from IDF-West to groundwater of the radiological risk drivers and Figure 5–989, the chemical hazard drivers. In addition to the inventory considerations discussed in the previous paragraph, release to groundwater is controlled by the transport properties of the COPC drivers and by the rate of moisture movement through the vadose zone. For the conservative tracers (iodine-129, technetium-99, chromium, fluoride, and nitrate), the amount released to groundwater is essentially equal to the amount released to the vadose zone.

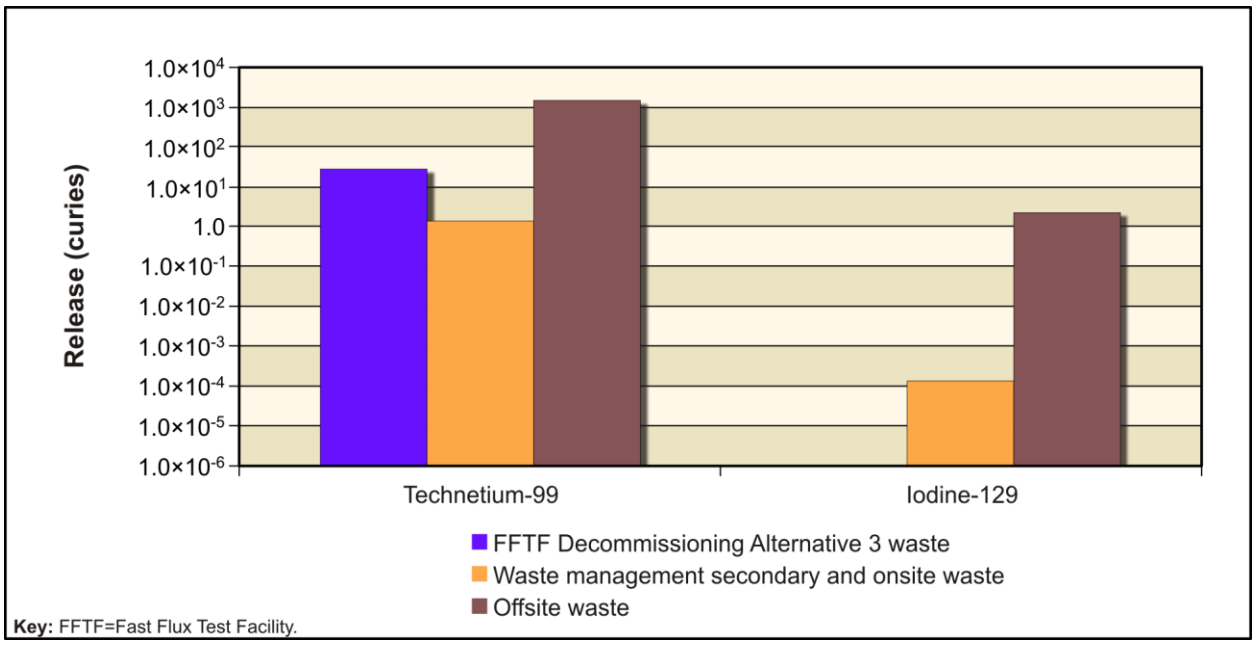


Figure 5–988. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Groundwater

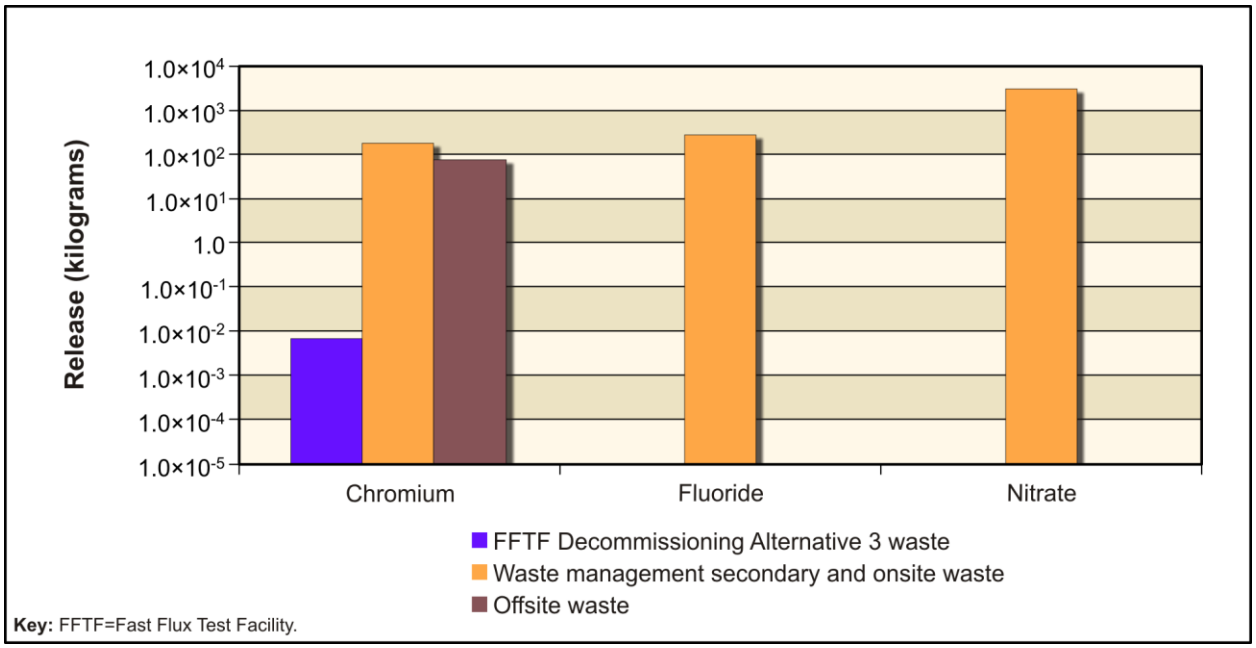


Figure 5–989. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from 200-West Area Integrated Disposal Facility to Groundwater

Figure 5–990 shows the estimated release from IDF-West to the Columbia River of the radiological risk drivers and Figure 5–991, the chemical hazard drivers. Release to the Columbia River is controlled by the transport properties of the COPC drivers. For the conservative tracers (iodine-129, technetium-99, chromium, and nitrate), the amount released to the Columbia River is approximately 97 to 100 percent of the amount released to the vadose zone.

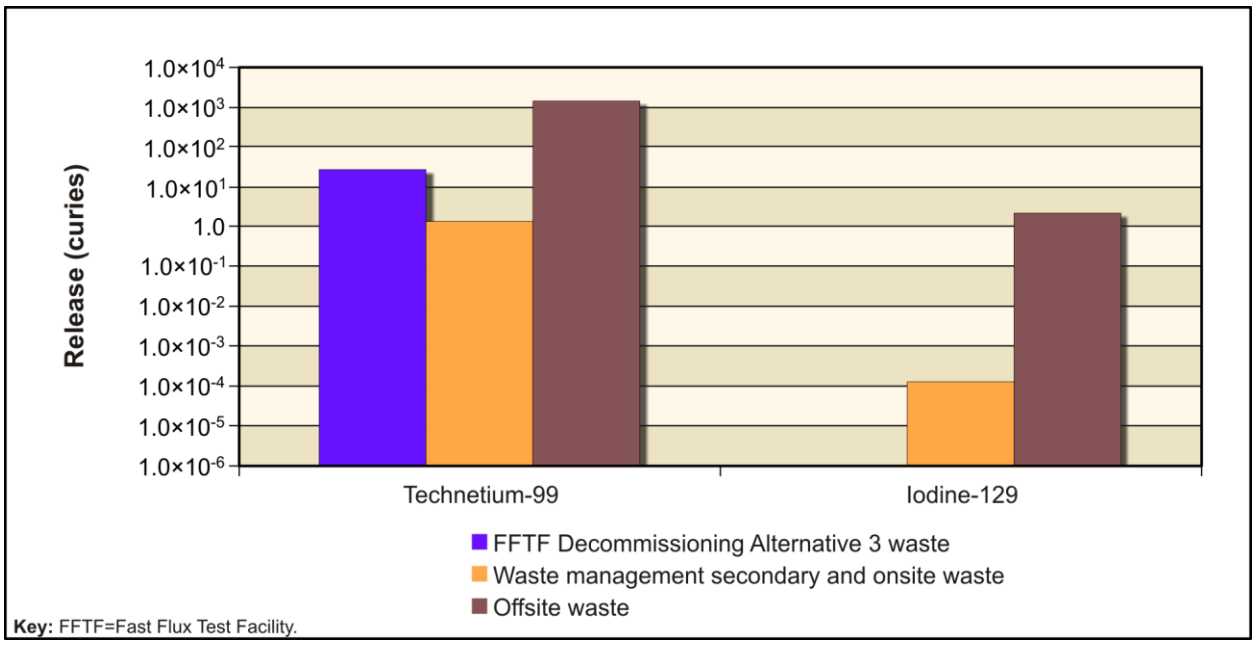


Figure 5–990. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from 200-West Area Integrated Disposal Facility to Columbia River

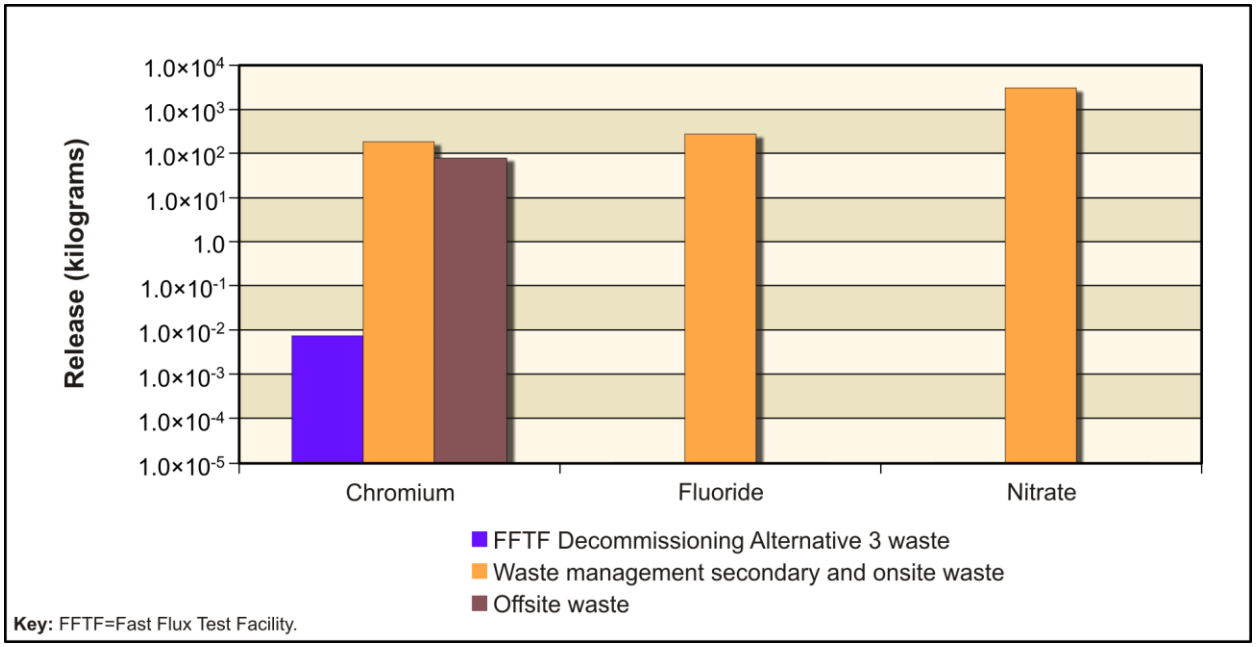


Figure 5–991. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from 200-West Area Integrated Disposal Facility to Columbia River

River Protection Project Disposal Facility

Figure 5–992 shows the estimated release from the RPPDF to the vadose zone of the radiological risk drivers and Figure 5–993, the chemical hazard drivers. The technetium-99 release is more than two orders of magnitude greater than the iodine-129 release from the RPPDF. Of the chemical hazard drivers, nitrate is the predominant COPC; its release is about two orders of magnitude greater than that of chromium.

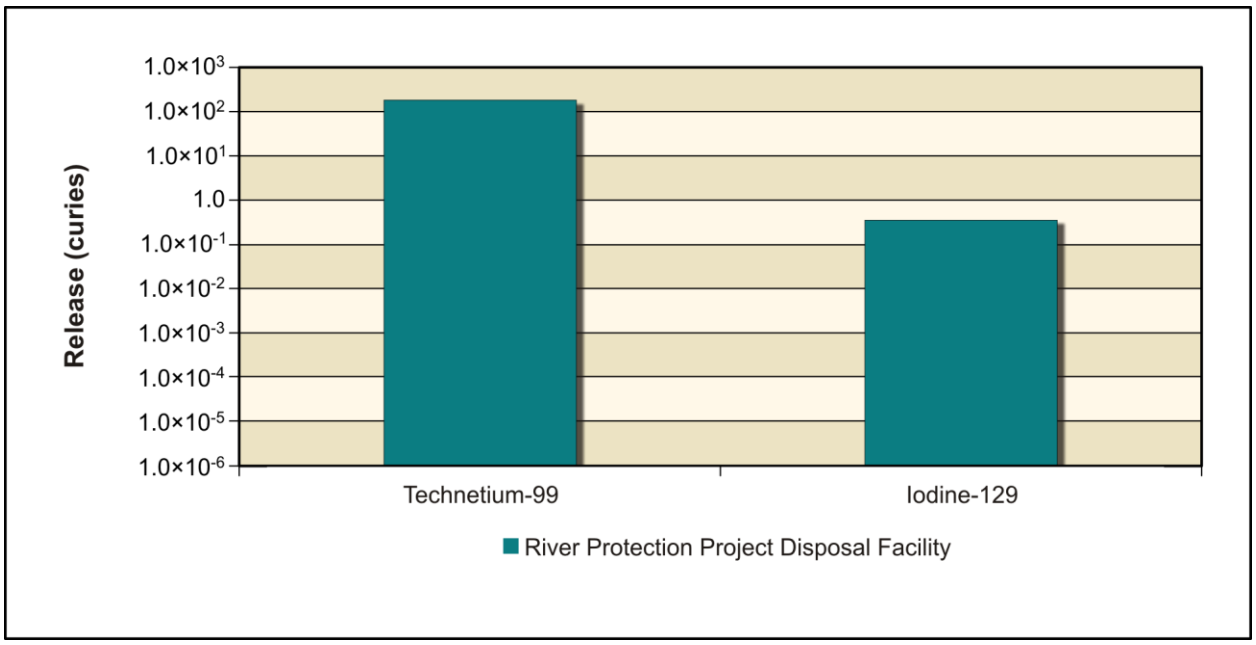


Figure 5–992. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from River Protection Project Disposal Facility to Vadose Zone

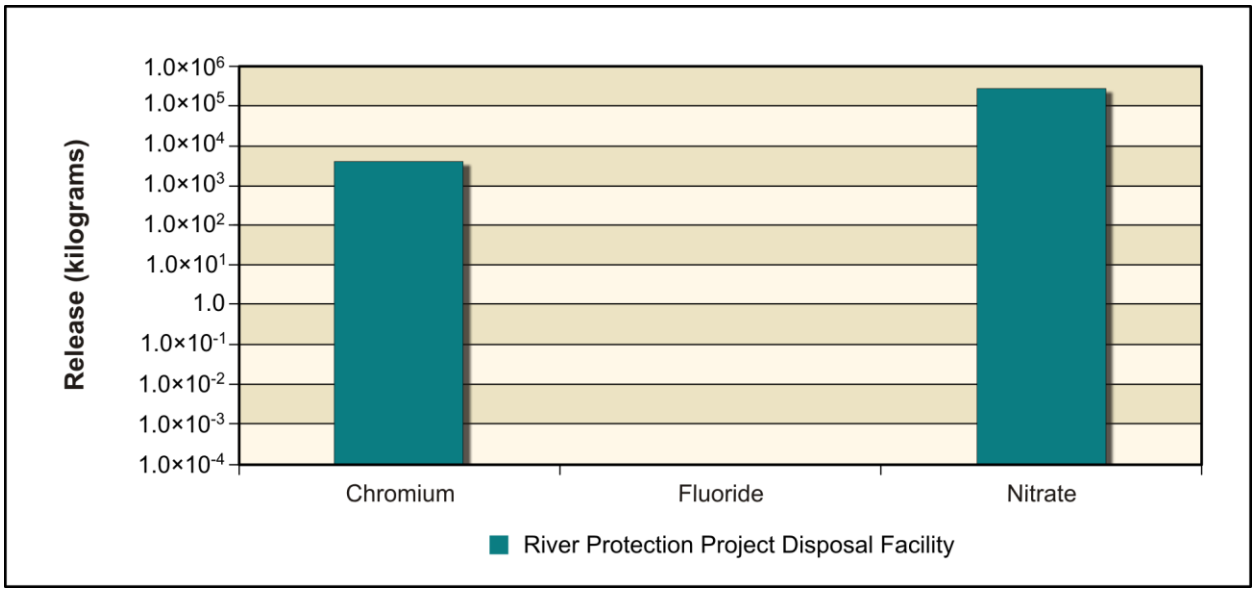


Figure 5–993. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from River Protection Project Disposal Facility to Vadose Zone

Figure 5–994 shows the estimated release from the RPPDF to groundwater of the radiological risk drivers and Figure 5–995, the chemical hazard drivers. For the conservative tracers (iodine-129, technetium-99, chromium, and nitrate), the amount released to groundwater is essentially equal to the amount released to the vadose zone.

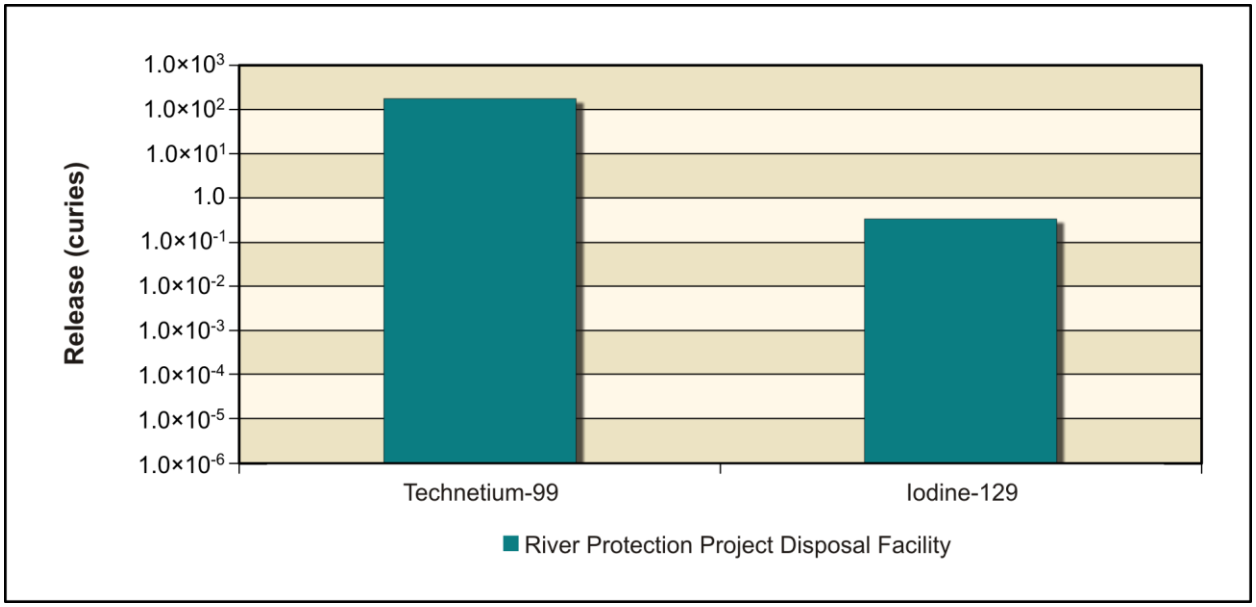


Figure 5–994. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from River Protection Project Disposal Facility to Groundwater

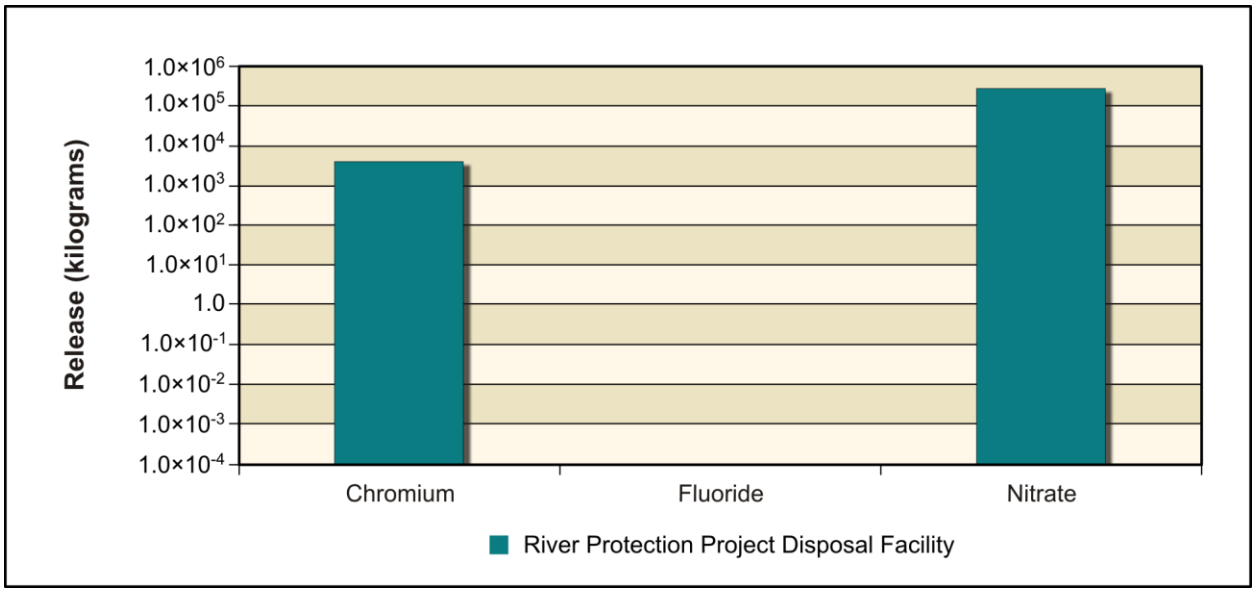


Figure 5–995. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from River Protection Project Disposal Facility to Groundwater

Figure 5–996 shows the release from the RPPDF to the Columbia River of the radiological risk drivers and Figure 5–997, the chemical hazard drivers. Essentially all of the inventory of radionuclides and chemicals released to groundwater reach the Columbia River.

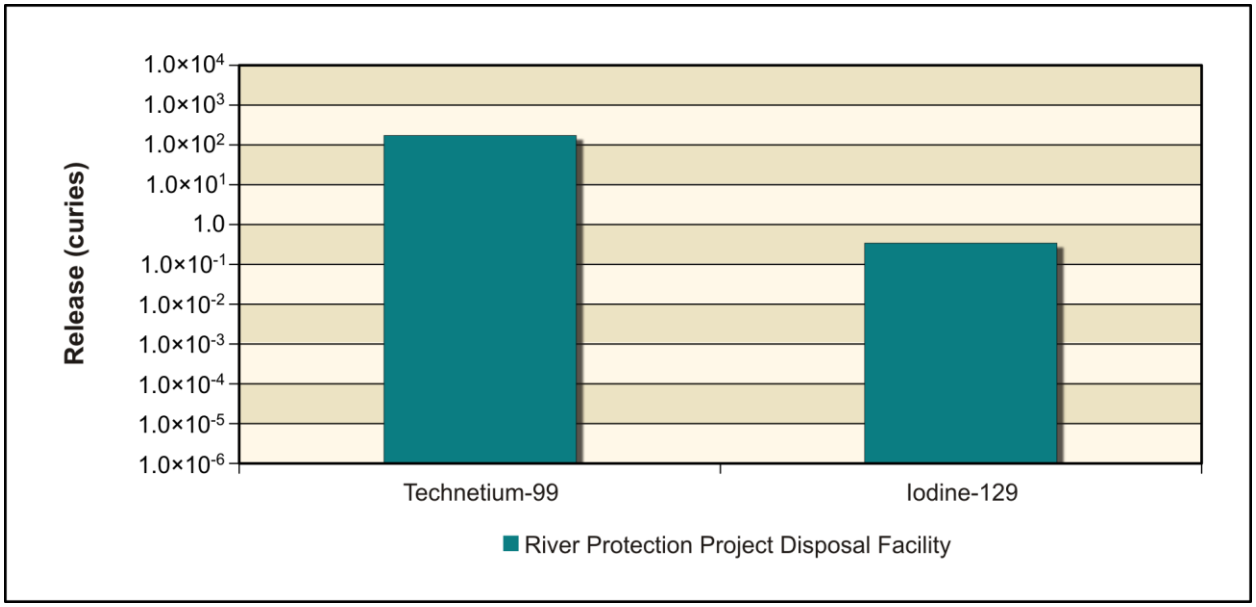


Figure 5–996. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Radionuclide Releases from River Protection Project Disposal Facility to Columbia River

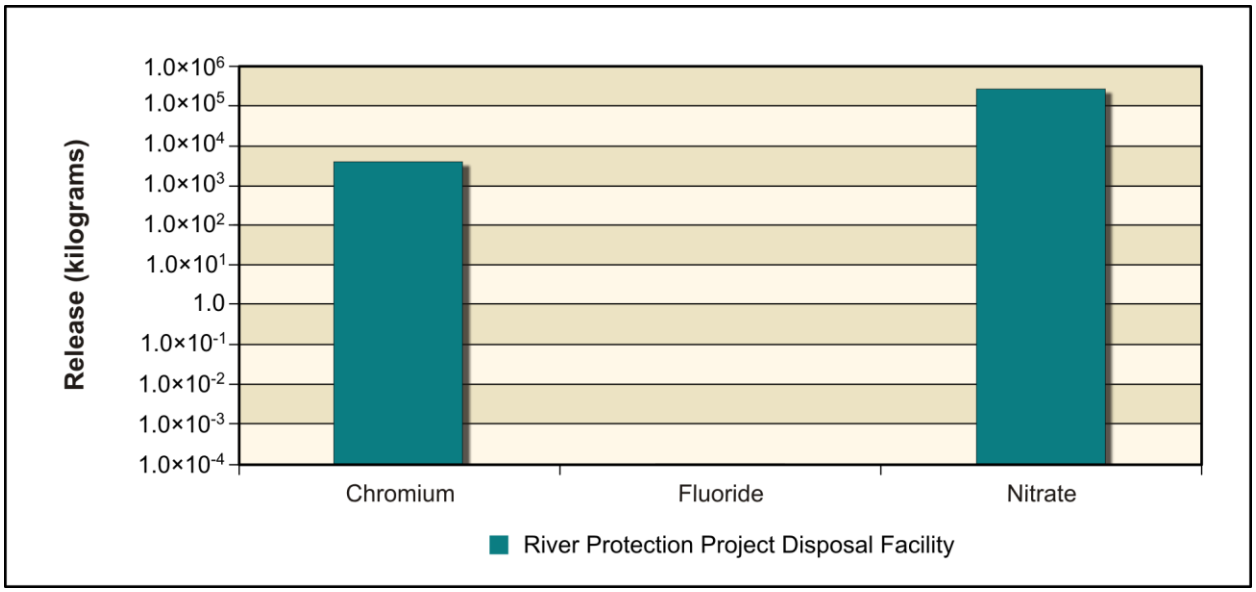


Figure 5–997. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chemical Releases from River Protection Project Disposal Facility to Columbia River

ANALYSIS OF CONCENTRATION VERSUS TIME

This section presents the impacts of Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, in terms of groundwater concentration versus time at the Core Zone Boundary and the Columbia River nearshore. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. The benchmark concentration of each radionuclide and chemical is also shown. Note that the concentrations are plotted on a logarithmic scale to facilitate visual comparison of concentrations that vary over five orders of magnitude.

Table 5–114 shows the maximum concentrations of the COPCs in the peak years at IDF-East, IDF-West, the RPPDF, the Core Zone Boundary, and Columbia River nearshore. Iodine-129 and technetium-99

concentrations both exceed their benchmarks at IDF-West, the Core Zone Boundary, and Columbia River nearshore around CY 3900. No other constituents exceed their benchmark concentrations under Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case.

Table 5–114. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Maximum COPC Concentrations in the Peak Year at IDF-East, IDF-West, and the RPPDF, Core Zone Boundary, and Columbia River Nearshore

Contaminant	IDF-East	IDF-West	RPPDF	Core Zone Boundary	Columbia River Nearshore	Benchmark Concentration
Radionuclide (picocuries per liter)						
Technetium-99	194	**13,200**	155	**1,370**	**1,670**	900
	(10,188)	(3818)	(3769)	(3859)	(3920)	
Iodine-129	0.8	**20.6**	0.3	**2.1**	**2.4**	1
	(9907)	(3794)	(3746)	(3937)	(3872)	
Chemical (micrograms per liter)						
Chromium	2	1	4	3	2	100
	(8251)	(3813)	(3710)	(3977)	(4632)	
Fluoride	0	1	0	0	0	4,000
	(1940)	(4014)	(3983)	(3937)	(4307)	
Nitrate	9,590	7	277	3,130	2,140	45,000
	(7983)	(3927)	(3789)	(7860)	(7994)	

Note: Corresponding calendar years shown in parentheses. Concentrations that would exceed the benchmark value are indicated in **bold** text.

Key: COPC=constituent of potential concern; IDF-East=200-East Area Integrated Disposal Facility; IDF-West=200-West Area Integrated Disposal Facility; RPPDF=River Protection Project Disposal Facility.

Figures 5–998 through 5–1001 show concentration versus time for iodine-129, technetium-99, chromium, and nitrate (the conservative tracers). Iodine-129 concentrations exceed the benchmark concentration at the IDF-West barrier, Core Zone Boundary, and Columbia River nearshore. The greatest exceedance of the benchmark concentration is at the IDF-West barrier, where the benchmark is exceeded by over an order of magnitude from approximately CY 3200 until CY 4800. Iodine-129 concentrations never exceed the benchmark concentration at the IDF-East barrier or the RPPDF barrier. The iodine-129 benchmark concentrations are exceeded by less than an order of magnitude at the Core Zone Boundary and Columbia River nearshore. Technetium-99 exhibits behavior similar to iodine-129, where concentrations at the IDF-West barrier exceed the benchmark by over one order of magnitude. The duration of the benchmark exceedance is approximately 1,500 years. In addition, the technetium-99 benchmark concentration is exceeded at the Columbia River nearshore from approximately CY 3500 to CY 5000. The benchmark concentration is exceeded from about CY 3500 to CY 4100 at the Core Zone Boundary. Chromium concentrations peak at over one order of magnitude below the benchmark. Peak nitrate concentrations, less than an order of magnitude below the benchmark, are evident at the IDF-East barrier around CY 8000. Nitrate does not exceed its benchmark concentration during the period of analysis.

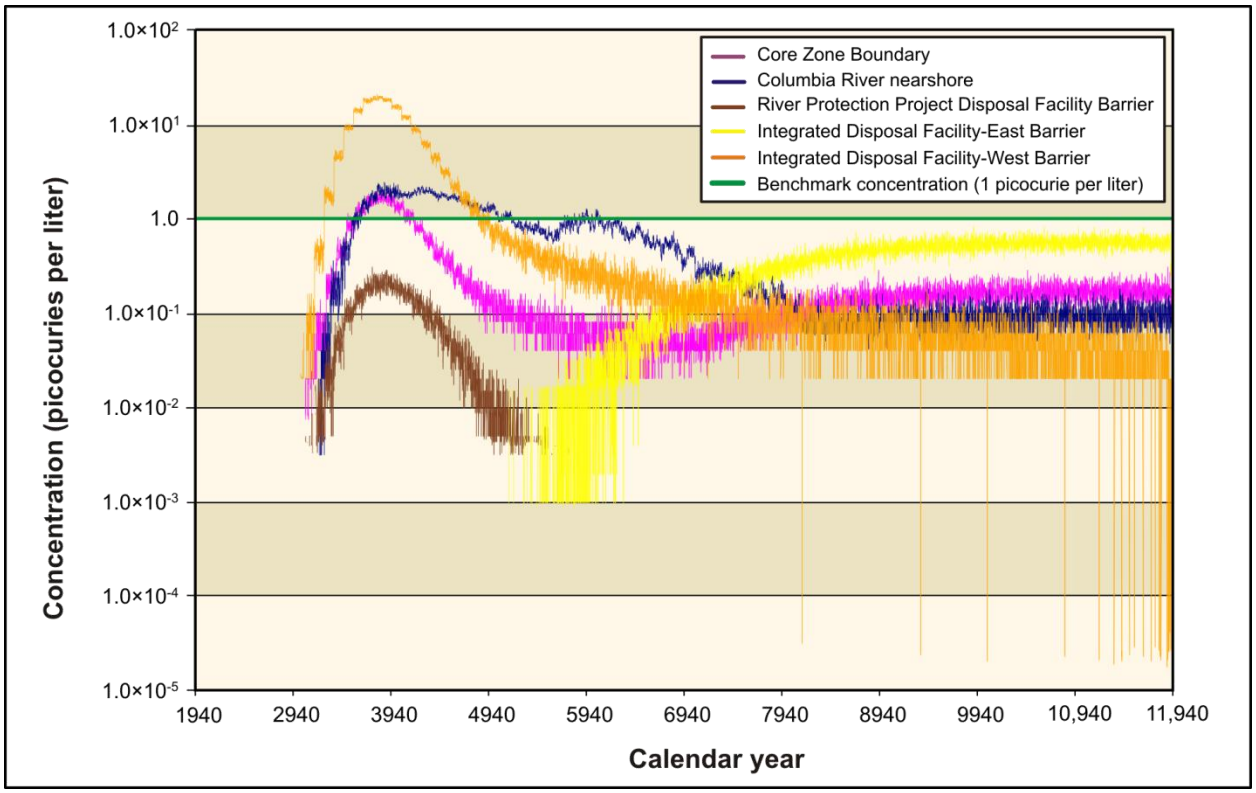


Figure 5–998. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Iodine-129 Concentration Versus Time

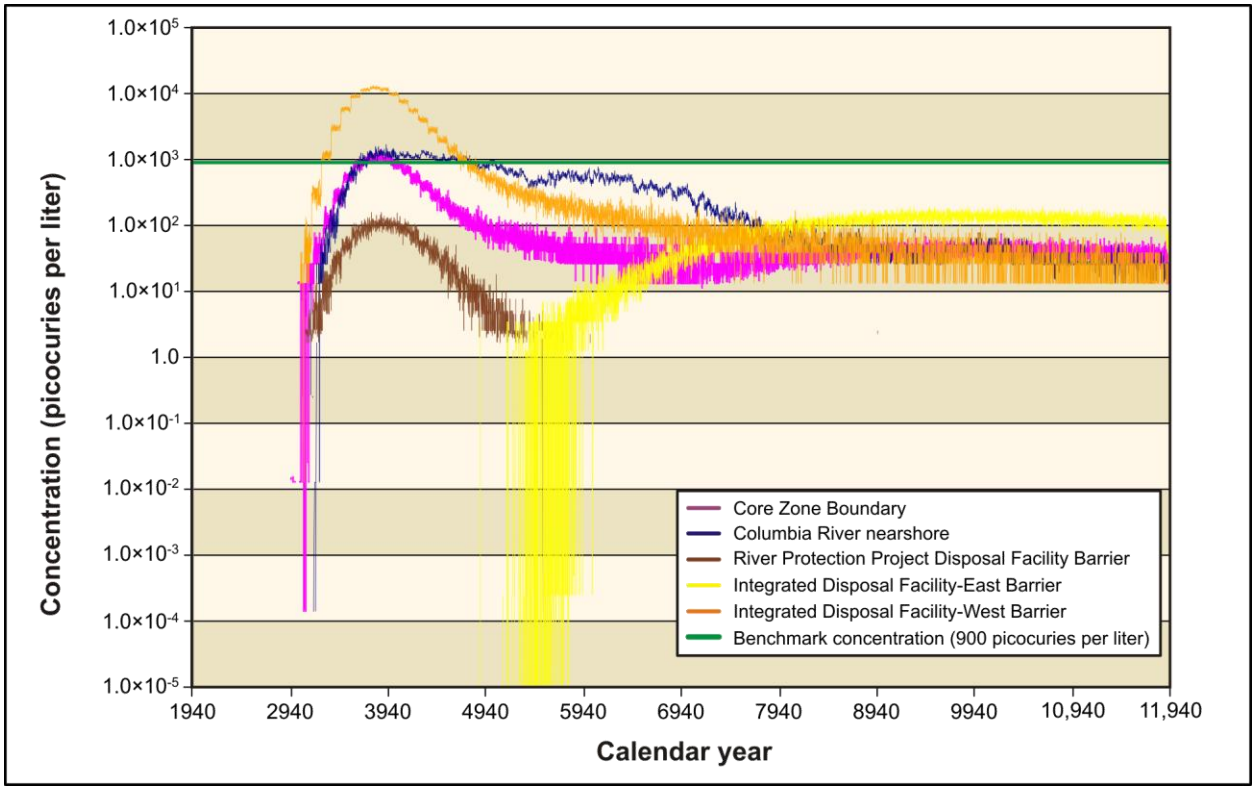


Figure 5–999. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Technetium-99 Concentration Versus Time

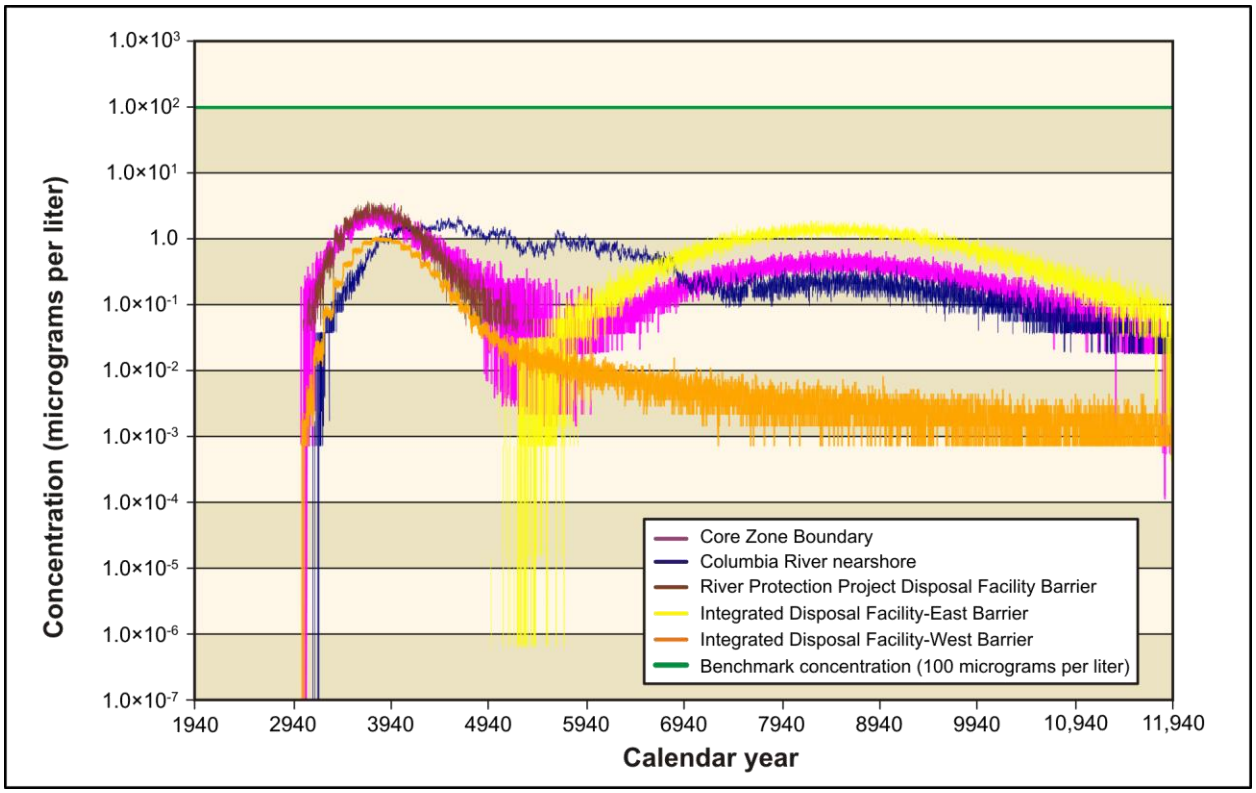


Figure 5–1000. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Chromium Concentration Versus Time

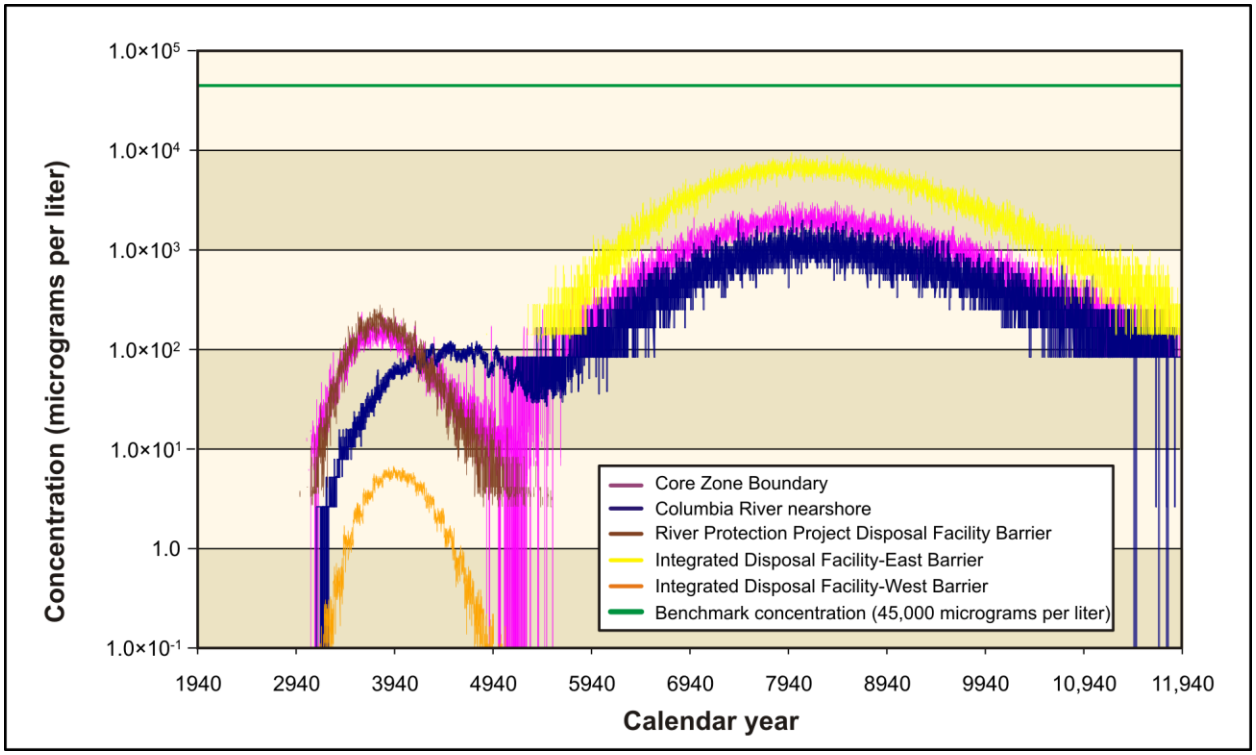


Figure 5–1001. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Nitrate Concentration Versus Time

Figure 5–1002 shows concentration versus time for total uranium. Because of the high retardation of total uranium, groundwater contamination doesn't appear until roughly CY 8000. Concentrations of total uranium continue to rise until the end of the 10,000-year period of analysis but remain at least six orders of magnitude below the benchmark concentration.

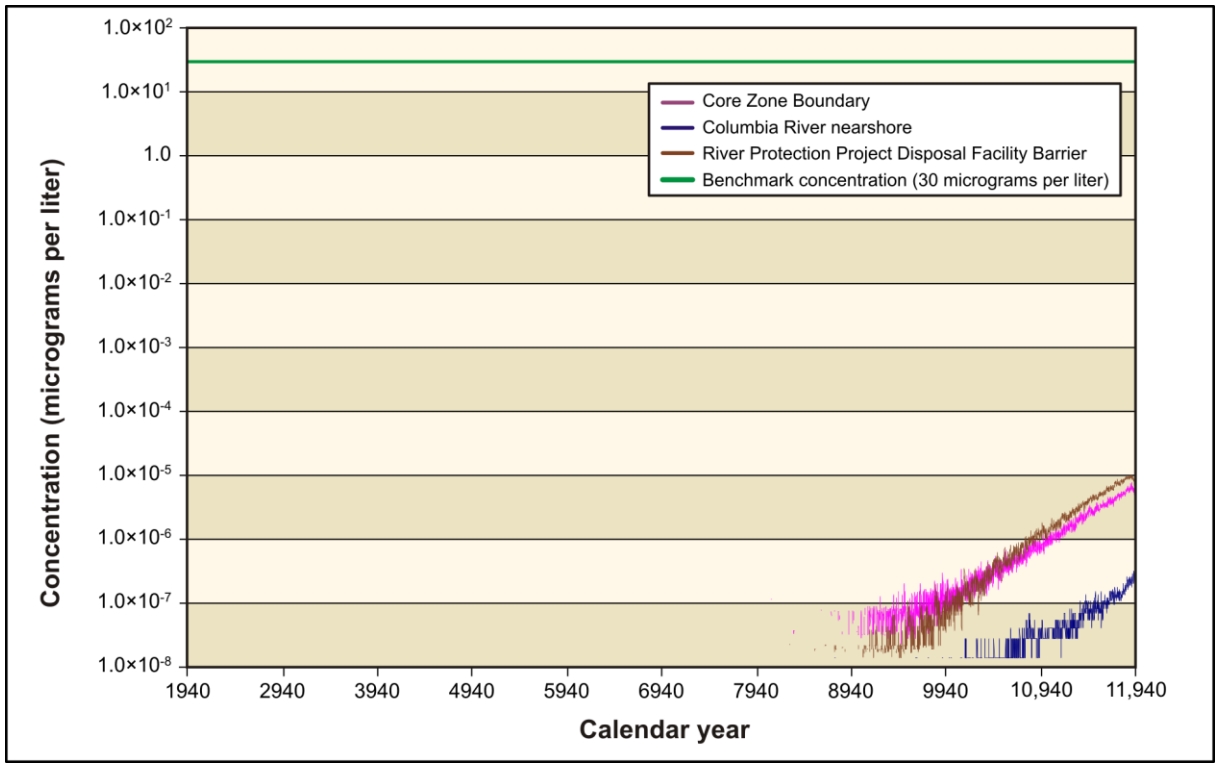
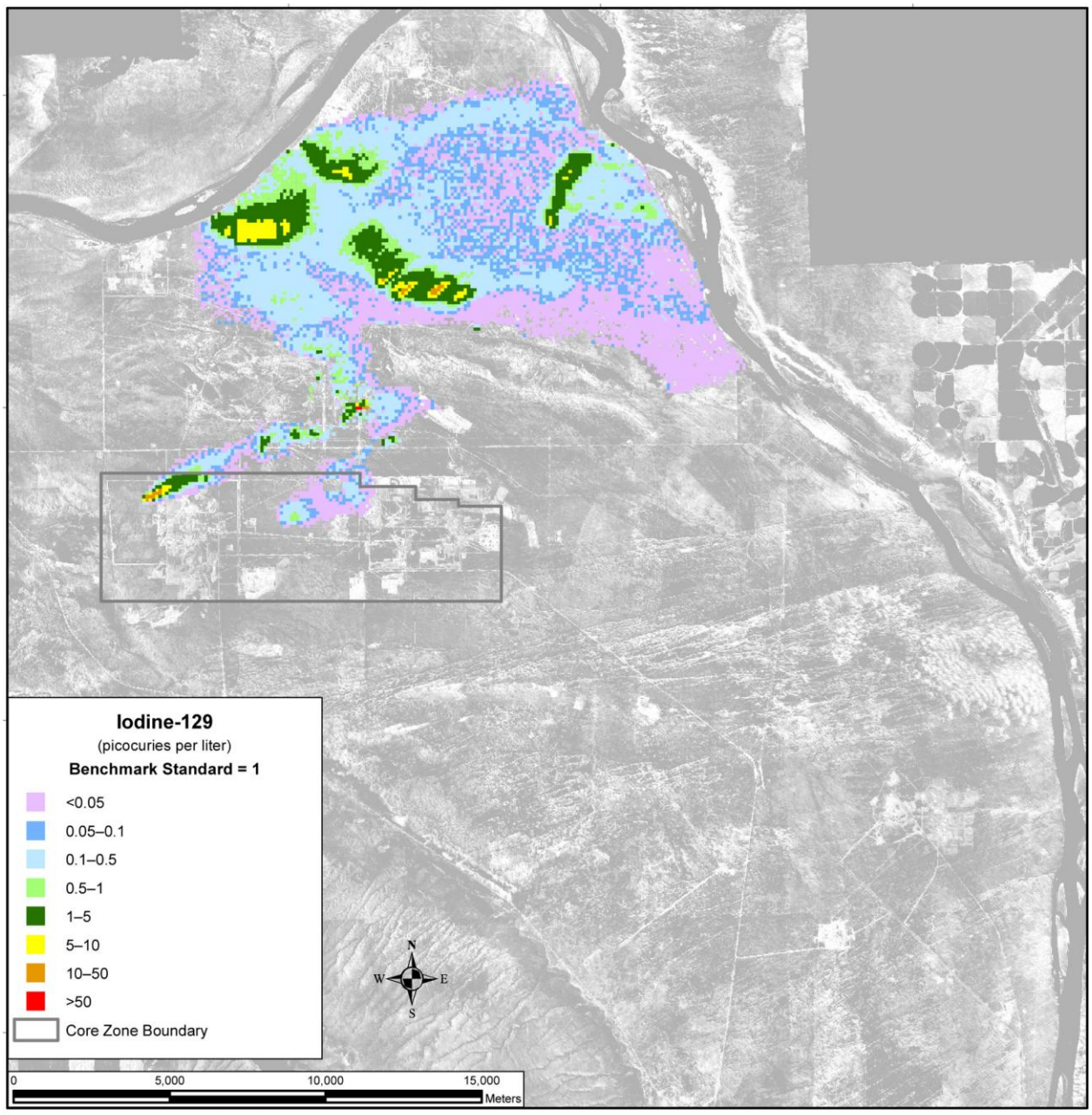


Figure 5–1002. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Total Uranium Concentration Versus Time

ANALYSIS OF SPATIAL DISTRIBUTION OF CONCENTRATION

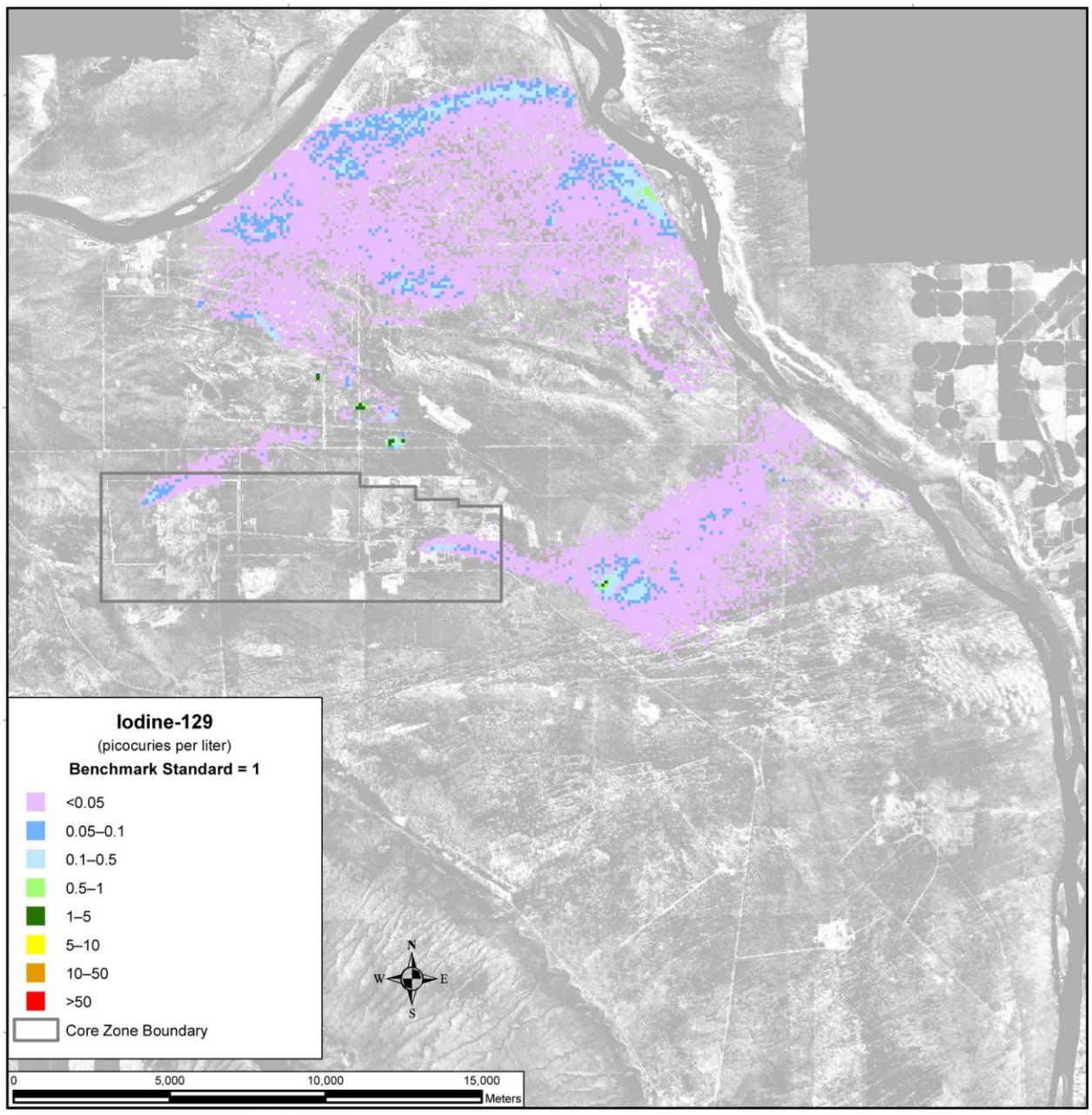
This section presents the impacts of Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, in terms of the spatial distribution of COPC driver concentrations in groundwater at selected times. Concentrations of radionuclides are in picocuries per liter; chemicals, in micrograms per liter. Concentrations of each radionuclide and chemical are indicated by a color scale that is relative to the benchmark concentration. Concentrations greater than the benchmark concentration are indicated by the fully saturated colors green, yellow, orange, and red in order of increasing concentration. Concentrations less than the benchmark concentration are indicated by the faded colors green, blue, indigo, and violet in order of decreasing concentration. Note that the concentration ranges are on a logarithmic scale to facilitate visual comparison of concentrations that vary over three orders of magnitude.

Figure 5–1003 shows the spatial distribution of iodine-129 concentrations in groundwater in CY 3890, when there is a concentrated plume, with peak concentrations 10 to 50 times greater than the benchmark, that stretches north from IDF-West and the RPPDF through Gable Gap. By CY 7140 (see Figure 5–1004), the plume from the RPPDF is reduced, but a new plume is beginning to form, traveling east from IDF-East. The peak concentrations in the second plume are greater than the benchmark. By CY 11,885, the plume continues to spread toward the river and the concentrations continue to increase (see Figure 5–1005). Technetium-99 (see Figures 5–1006 through 5–1008), chromium (see Figures 5–1009 through 5–1011), and nitrate (see Figures 5–1012 through 5–1014) show similar spatial distributions at selected times, but the concentrations remain lower, similar to the later plumes mentioned above. Iodine-129, technetium-99, chromium, and nitrate are all conservative tracers (i.e., they move at the pore-water velocity).



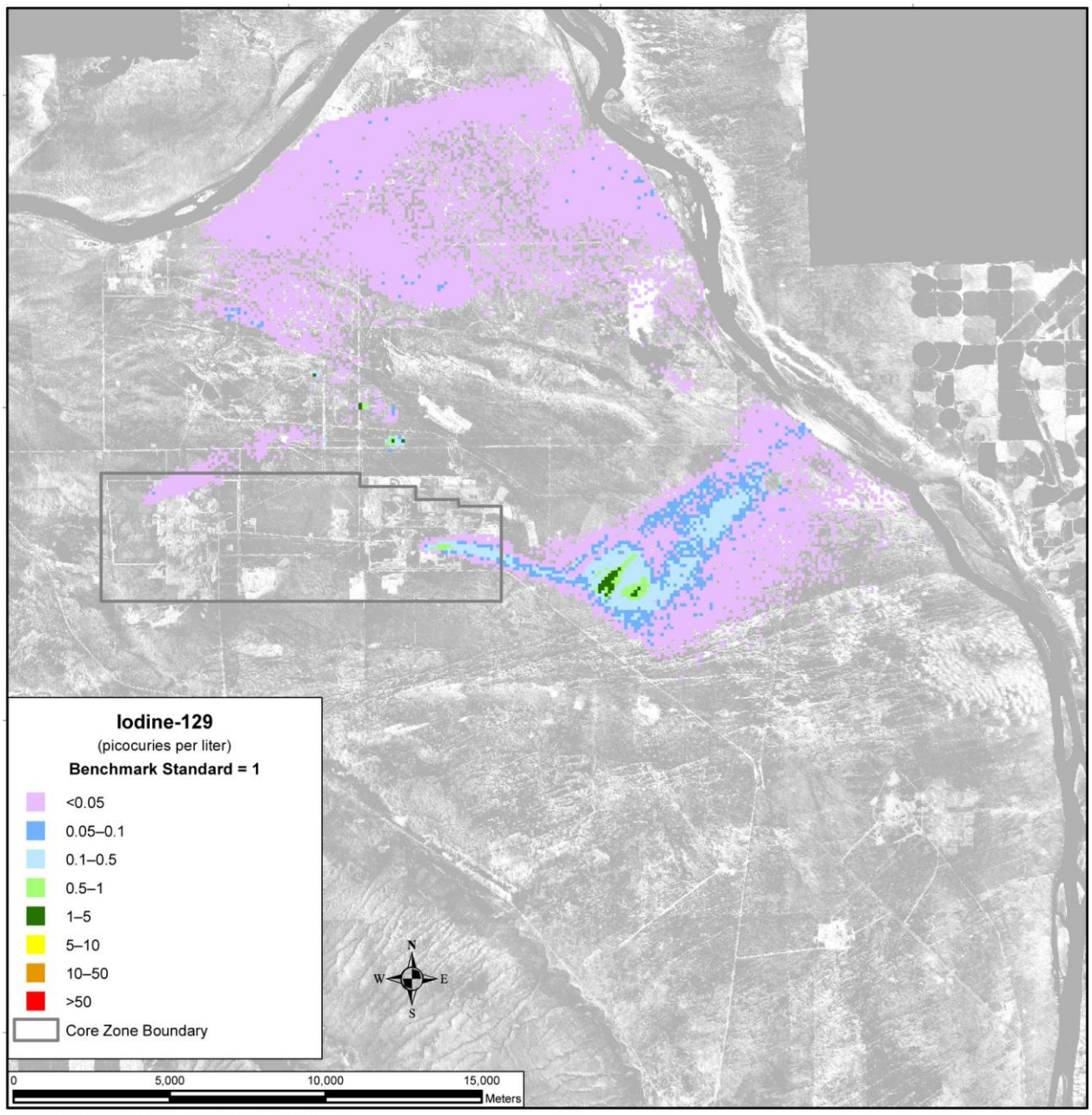
Note: To convert meters to feet, multiply by 3.281.

Figure 5–1003. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 3890



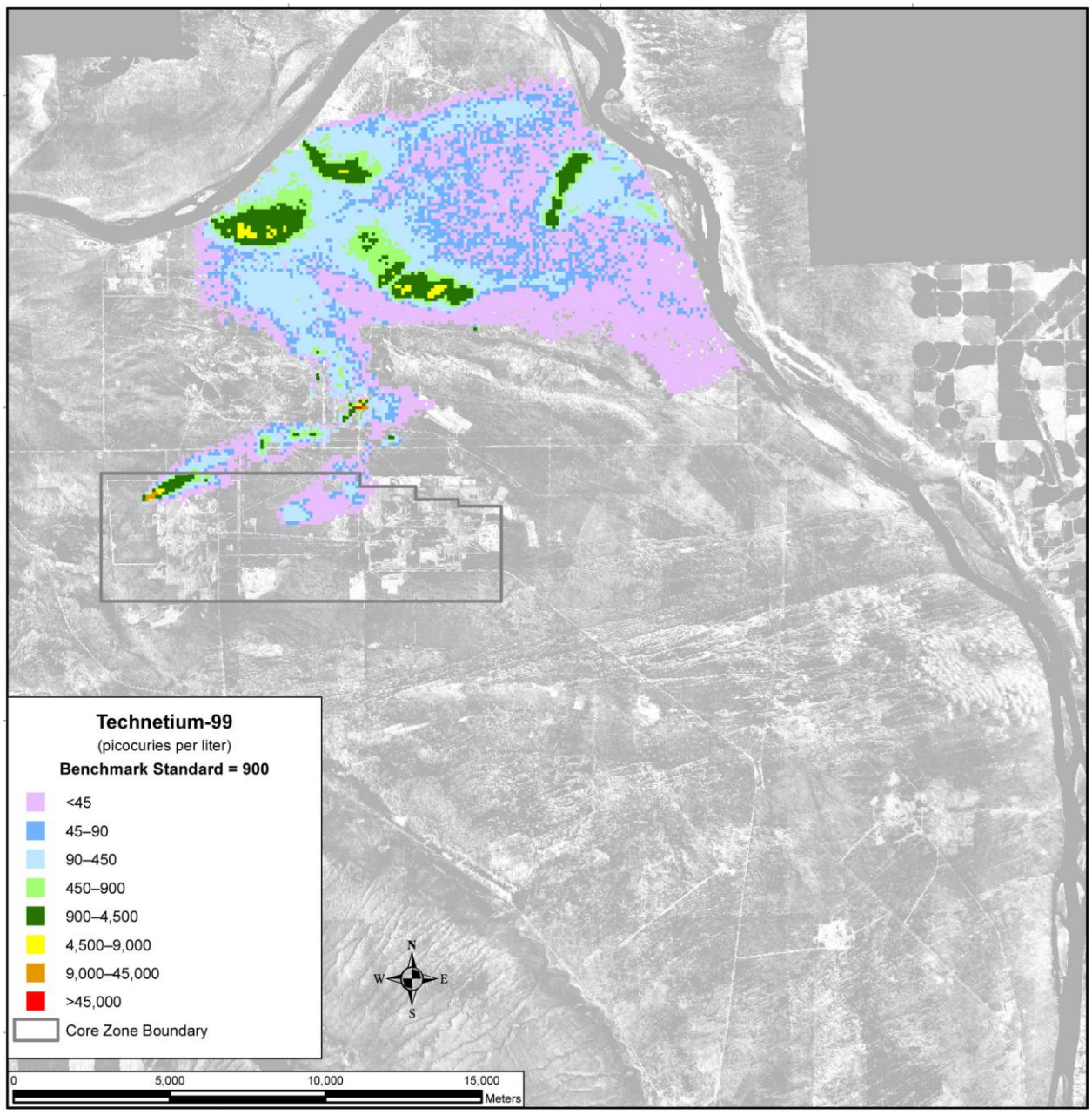
Note: To convert meters to feet, multiply by 3.281.

Figure 5–1004. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 7140



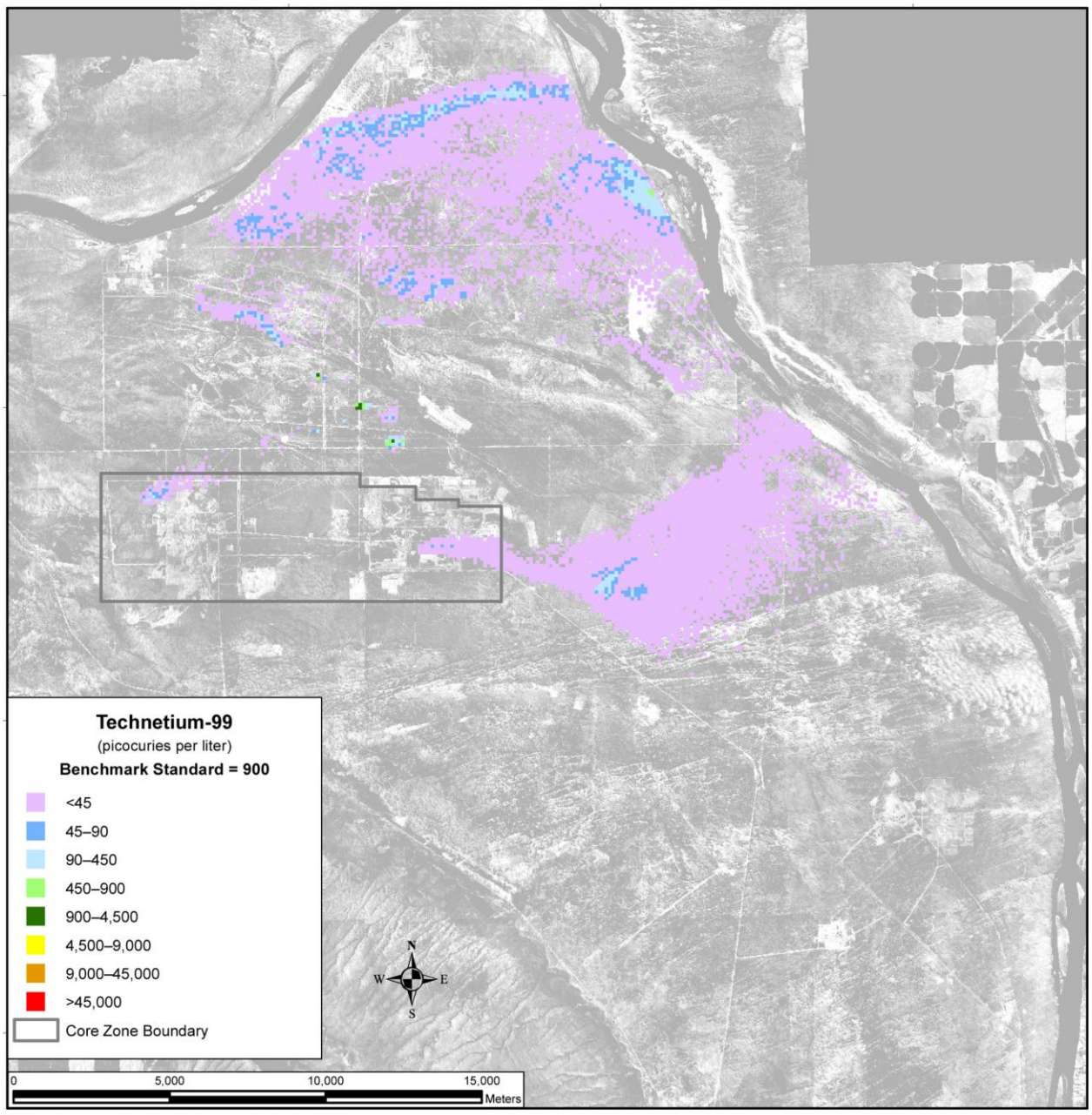
Note: To convert meters to feet, multiply by 3.281.

Figure 5–1005. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Iodine-129 Concentration, Calendar Year 11,885



Note: To convert meters to feet, multiply by 3.281.

Figure 5–1006. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 3890



Note: To convert meters to feet, multiply by 3.281.

Figure 5–1007. Waste Management Alternative 3, Disposal Group 2, Subgroup 2-B, Base Case, Spatial Distribution of Groundwater Technetium-99 Concentration, Calendar Year 7140